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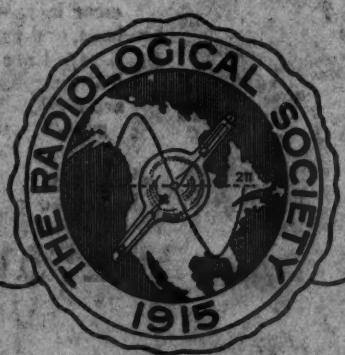

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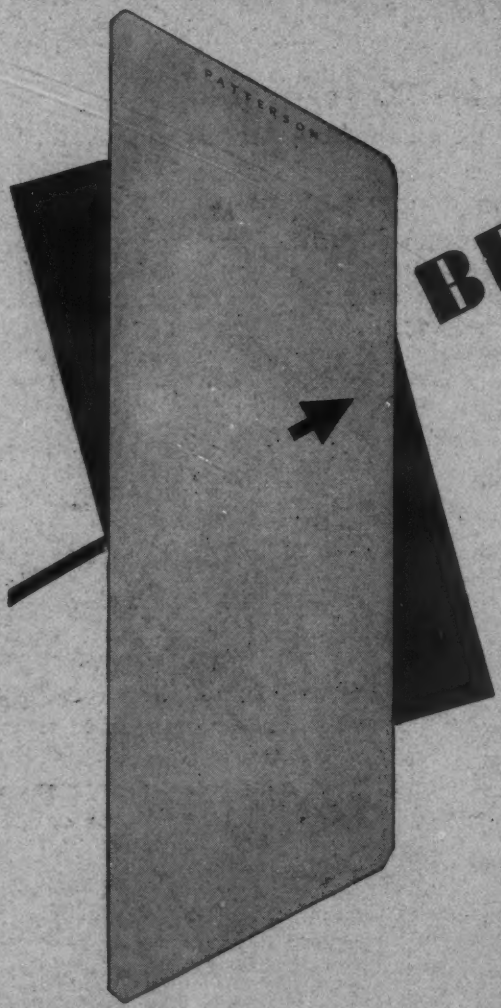

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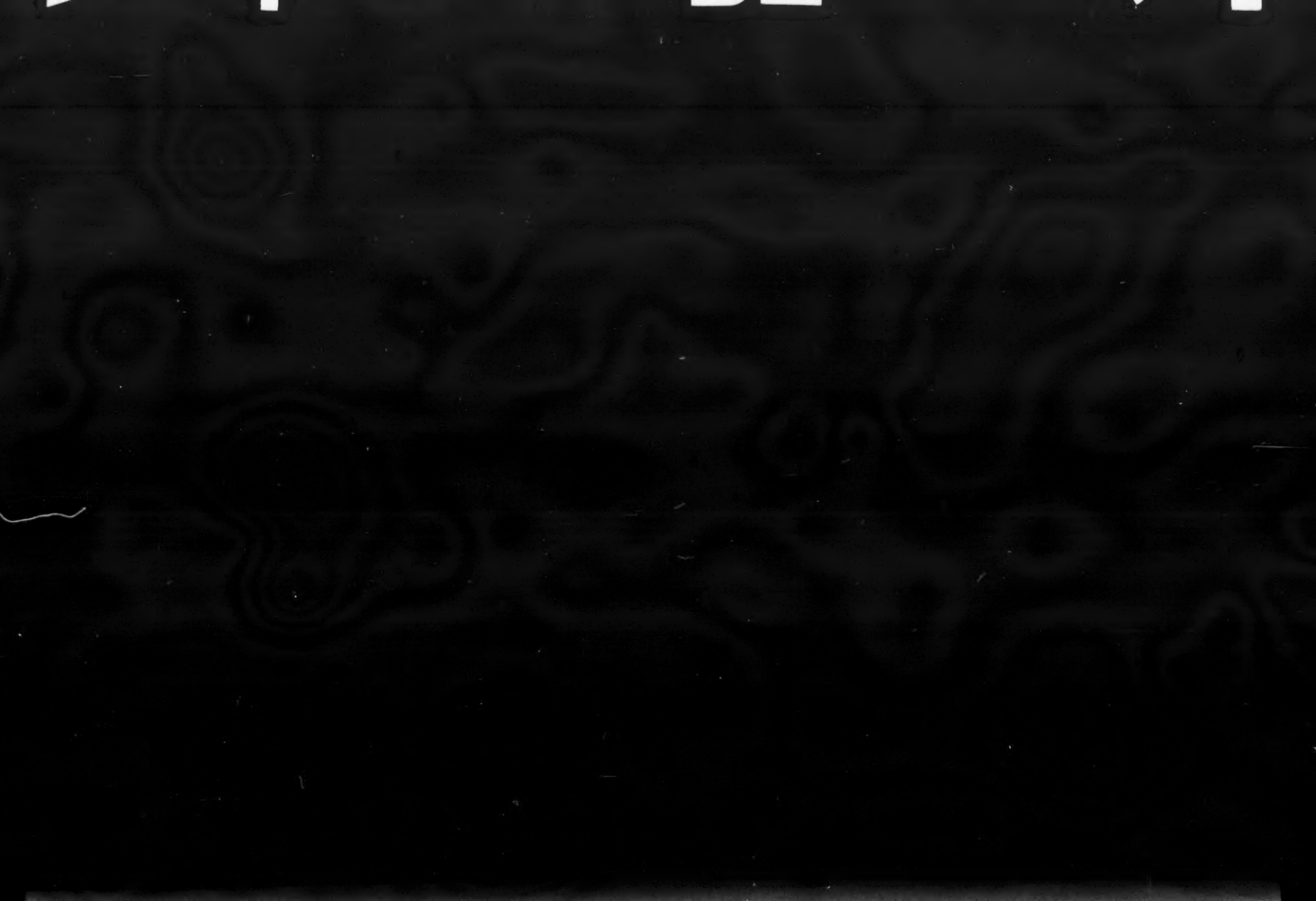

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A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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THE RELATIVE BIOLOGICAL EFFECTIVENESS OF X-RAYS AND GAMMA RAYS[1]

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INTRODUCTION

THE effect of ionizing radiations in a living cell depends on three physical factors: (1) The *intensity* of the radiation at the cell (considered as a point); (2) the *time* during which the cell is exposed to the radiation, and (3) the *quality* of the radiation reaching the cell. Theoretically the biological effect should be influenced by changes in any one, any two, or all of the above factors. If this conclusion is to be tested experimentally, one must be able to measure the biological effect as well as the intensity, duration of exposure, and quality of the radiation. Furthermore, if it is desired to investigate the influence of only one of the three factors, it is essential that the other two be kept constant, and that all other conditions remain the same. This principle was strictly adhered to in the biological experiments to be described in the present paper, only the quality of radiation being changed.

"Biological effect" is a general expression which should be used with considerable care. Ionizing radiations are capable of producing an infinite number of biological effects. Any quantitative relationships which may be obtained experimentally refer only to the particular biological effect investigated, and are not necessarily true for all biological effects. For this reason our experiments were carried out with more than one biological material, and the observed effect, or "end point," was also different.

In attempting to determine the influence of one of the three physical factors on a particular biological effect, it is advantageous to vary the factor within the widest practical limits. It is then possible to detect differences which otherwise might be masked by experimental errors, which, unfortunately, are always of considerable magnitude in biological experiments. For this reason gamma rays, and X-rays produced at 165 K.V., with a filter of 2.04 mm. Cu, were used in our experiments. The quality factor in this case is very different, and yet no complications due to uneven distribution of radiation in the material are introduced.

In order to fulfill the requirement of equality of the other physical factors, it is necessary to base the measurements of the intensity of X-rays and gamma rays on some effect which both are capable of producing (other than the one under investigation). As such an effect, one might choose the blackening of a photographic plate, the change in a chemical compound, or even a biological change. But in view of the uni-

[1]To be presented at the Third International Congress of Radiology, Paris, July, 1931.

versal adoption of air ionization as the effect by which X-rays are measured, it is desirable to use this effect for both qualities of radiation. Furthermore, it is desirable to express the measurements in terms of the international unit of X-radiation.

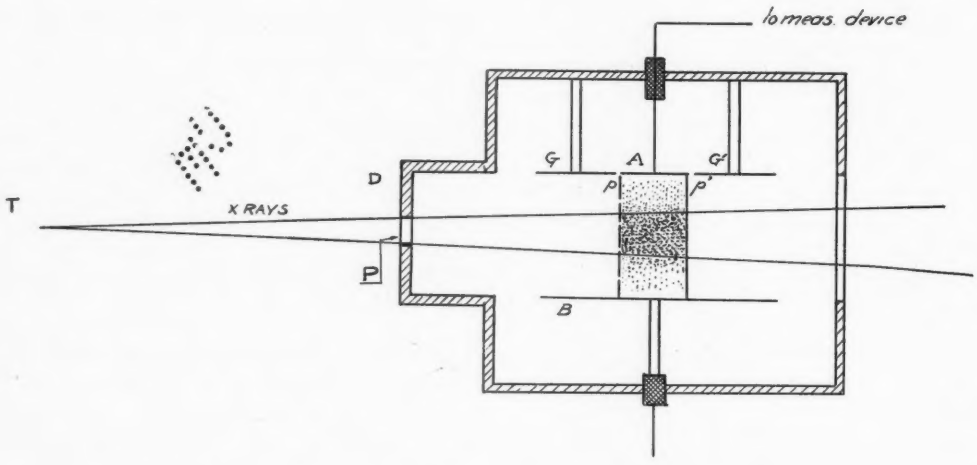


Fig. 1. Measurement of X-rays with standard ionization chamber.

The measurement of gamma rays in roentgens by direct means involves certain experimental difficulties which account for the fact that no data can be obtained from the literature. Kessler and Sluys (1) described, in 1929, an apparatus by which they were planning to make such measurements, but to date they have not published their results. Measurements by indirect means have been reported by many investigators (2-11). The results suffer from the limitations of the methods used, and, in addition, are quite discordant. In the present paper are incorporated the results of our direct measurement of gamma rays in roentgens. Since they differ considerably from any estimates previously reported, we shall describe the work in detail.

PART I (PHYSICAL)

1. *Requirements for the Measurement of X-rays in Roentgens.*—The definition of the International Unit of X-radiation — the "roentgen," or "r,"—imposes certain requirements on the method and apparatus used for its experimental determination. The definition is as follows: "The International Unit of X-radiation is the quantity of X-radiation which, when the secondary electrons are fully utilized and the wall effect of the chamber is avoided, produces in one cubic centimeter of atmospheric air, at 0° C. and 76 cm. mercury pressure, such a degree of conductivity that one electrostatic unit of charge is measured at saturation current." For the purpose of our discussion the principal requirements are: (1) that the secondary electrons must be fully utilized, and (2) that the wall effect of the chamber must be avoided.

Since the unit is based on a certain amount of ionization in one cubic centimeter of air, it follows that experimentally one must determine the ionization in a *known volume* of air. But, according to requirement (2) above, this volume cannot be bounded by walls. Hence it is necessary in practice to resort to indirect means for the determina-

tion of the volume of air the ionization of which is being measured.

The arrangement which is used now quite generally for this purpose is shown in Figure 1. In a lead-lined case are mounted by means of suitable insulators two parallel plate electrodes, A and B. Electrode A is short in comparison to B, but has two "guard" plates, G and G′, situated in its plane but separated from it by narrow air spaces. The purpose of these plates is to insure a uniform electrostatic field between electrodes A and B, so that only ions produced between the imaginary planes p and p′ are collected by electrode A. A diaphragm, D, at one end of the ionization chamber allows a narrow pencil of X-rays to pass between the electrodes and emerge at the other end of the chamber without striking the electrodes or any part of the enclosure.

With such an arrangement it is possible to measure the intensity of the X-ray beam at point P in terms of the roentgen. The measuring instrument connected to A determines the magnitude (in electrostatic units) of the electric current passing between electrodes A and B, due only to the ionization produced between the parallel planes p and p′. The diaphragm D determines the cross-section of the beam at P which produces this ionization. Since, in the case of ordinary X-rays, absorption by the air between P and p is negligible, the ionization current recorded by the instrument is the same as would be produced at P by the same beam in the air enclosed within an imaginary cylinder, having a base equal to the area of the diaphragm aperture and a height equal to the distance between planes p and p′. Both of these quantities can be measured directly, and, therefore, one can determine the virtual volume in which the ionization current was measured. Dividing then the value of the current in electrostatic units by the value of this volume in cubic centimeters, one gets the intensity of the beam *at point P* in electrostatic units of current per cubic centimeter. Since the roentgen corresponds to one electrostatic unit of charge per cubic centimeter and 1 e.s.u. of current = 1 e.s.u. of charge per second, we can express the intensity of the beam in roentgens per second or roentgens per minute.

With an ionization chamber of the type described here, the requirement of "complete utilization of the secondary electrons" is met by the proper spacing of the electrodes A and B. X-rays passing between these electrodes liberate high speed electrons in the air which travel in all directions. These, in turn, ionize air. If the electrodes are close together some of the electrons will impinge on the plates before their energy has been utilized fully in the process of ionizing air. Electrons liberated by 200 K.V. X-rays may travel more than 80 cm. through atmospheric air. Accordingly the theoretical spacing for the electrodes in a chamber intended for measurements of these X-rays should allow this distance between the periphery of the radiation beam and the electrodes. However, the electrons follow a zigzag path through the air, and, while the actual distance travelled may be large, they do not get very far from the confines of the beam. It is found experimentally that little is gained by placing the electrodes at a greater distance than a few centimeters from the periphery of the beam.

In the above discussion we have assumed tacitly that the beam to be measured originated from a "point source." Let us consider now the case of a distributed source, which is really what one has to deal with in practice.

Every point of the source S, in Figure 2, sends a beam of radiation to the diaphragm, D, so that the resultant beam entering the chamber has the outline shown in the figure. In this case, also, the area of the diaphragm aperture and the width of the col-

lecting electrode A determine the volume in which the ionization current is measured. It should be noted that in this case the spacing between the electrodes must be considerably larger because the beam inside the chamber is more divergent than in the case of the point source. But aside from this, the intensity of radiation at point P can be determined in roentgens per minute in the same manner, whether we have a point or a distributed source.

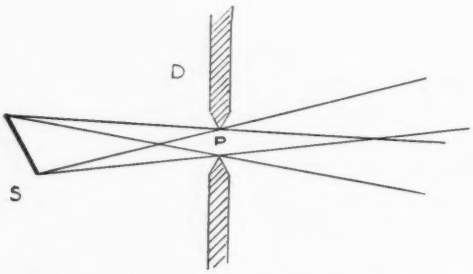


Fig. 2. Distributed source of radiation and sharp-edged diaphragm.

It is very important to note, however, that the diaphragm in Figure 2 is beveled to a sharp edge, and that this sharp edge forms the limits of the aperture and determines the cross-section of the beam at this point. If the diaphragm is thick and the aperture cylindrical, as shown in Figure 3, its cross-section is not effective for all points of the source S. For instance, the beam emanating from point *e* which enters the chamber (the cross-hatched portion in Figure 3) has a smaller cross-section than the beam originating at *c*. This, of course, is an exaggerated condition which does not obtain in the usual X-ray measurements. With the X-rays and distributed sources encountered in practice it is not necessary to use a very thick diaphragm and the aperture can be tapered sufficiently to avoid the complications illustrated in Figure 3, without introducing an appreciable error in the cross-section of the beam due to the rays which are capable of passing through the thinner parts of the diaphragm edge.

On the other hand, when one attempts to use a chamber of this sort to measure radiation emitted by a distributed source capable of passing through several centimeters of lead, the design of a suitable diaphragm presents a very difficult problem. This is particularly true in the measurement of gamma rays on account of the fact that the limited amount of radium available precludes the placing of the source at a great distance from the ionization chamber.

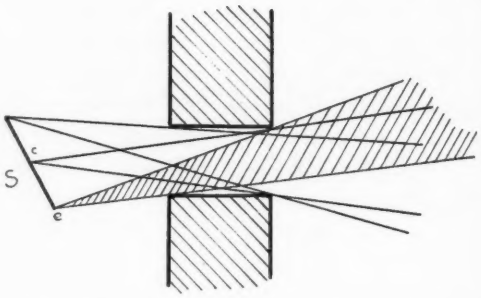


Fig. 3. Influence of the thickness of the diaphragm on the beam of radiation from a distributed source.

2. Provision of a Well-defined Gamma-ray Beam.—From the preceding discussion it is evident that in order to measure gamma rays by means of an "open air" ionization chamber, it is necessary in the first place to devise some means for producing a well-defined beam of radiation, the cross-section of which at a given point can be determined accurately. The scheme which we decided to use is illustrated in Figure 4. A is a lead cylinder 30 cm. in diameter and 36 cm. high. It has a cylindrical hole in the center 3.9 cm. in diameter and 23.5 cm. deep. Into this hole may be lowered any one of the lead plugs L (already in position), M, S, or B. The first three of these have conical holes

as shown in cross-section, while B is solid throughout, except for a small hole at the bottom. Plugs L, M, and S were made by pouring molten lead into thin brass tubes in which conical cores of the desired dimensions had been fitted accurately. One of these cores is shown at C in Figure 4. Particular care was exercised in their construction to make sure that they were conical and coaxial with the brass tubes into which they were fitted. The castings obtained had smooth conical holes, with base diameters of 25.8, 18.31, and 12.18 mm., respectively. At the bottom end of each plug a cylindrical hole 6.3 mm. in diameter and 23 mm. deep was drilled. This hole truncates the cones at a depth of 21 cm. from the base, where the diameter is 4 millimeters. A paper fiber plug, D, was made to fit into the bottom receptacle of each lead plug. A hole 1.5 mm. in diameter was drilled along the axis of the fiber plug.

As a source of gamma rays, radon was used. It was collected in thin-walled capillary glass tubes 12 to 14 mm. long and of such diameter as would permit the use of three such tubes in the bore of the fiber plug D. One or more of these tubes was placed at one end of plug D, being held in place by a wooden pin inserted into the bottom part of the hole. A brass disc, 2 mm. thick, was made to fit the bottom receptacles in plugs L, M, S, and B, and act as a filter. The large cone, plug L, with the radon tube and brass filter in their proper proportions is shown in the large lead block, A. It should be noted that the geometrical relation of the truncated cone and the radon tube is such that every point of the radiating source is "visible" through the cone: that

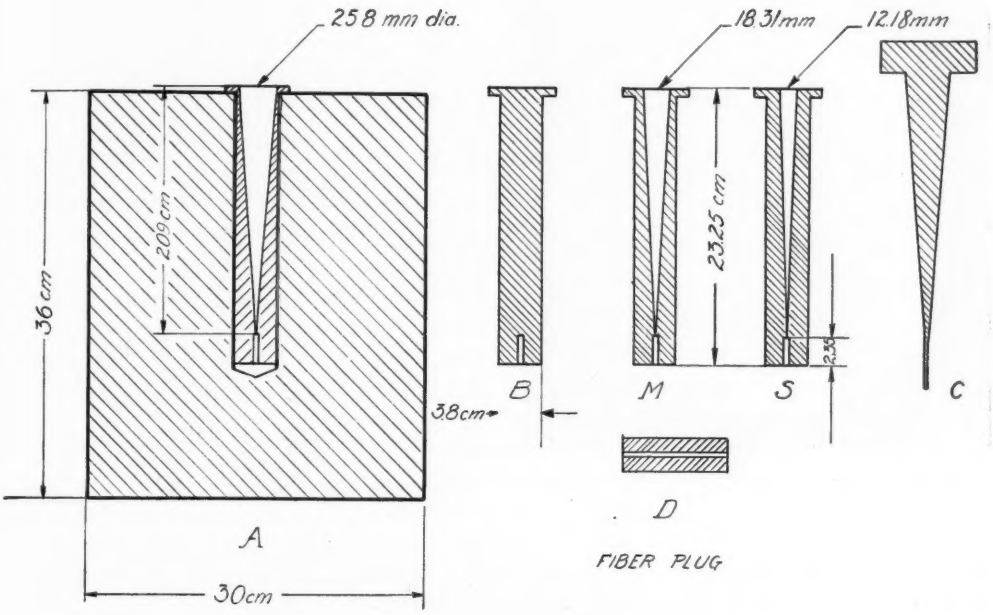


Fig. 4. Lead block and cones used to provide well defined beams of gamma rays.

is, the geometrical apex of the cone falls beyond the far end of the radon tube.

By using this arrangement we were able to obtain well defined beams of gamma rays. The degree of definition may be judged from

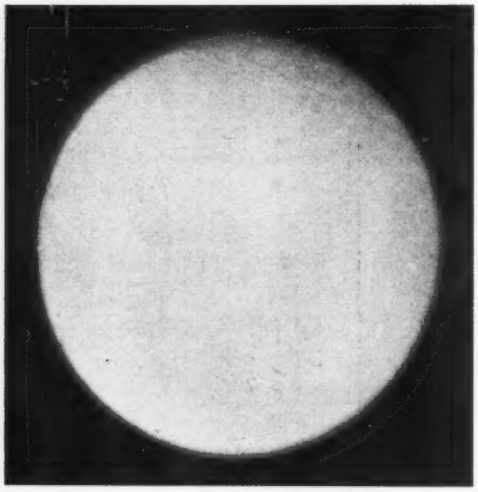


Fig. 5. Positive of autophotograph of gamma-ray beam from large cone. Film placed 85 cm. from source.

Figure 5. It shows a "positive" of the effect of the gamma-ray beam on a photographic plate placed at a distance of 85 cm. from the base of the large cone, L, in the lead block, A.

The reason for using in the experiment three cones of different solid angles will be evident from the following discussion. In practice it is impossible to have a *point* source of radiation. With our arrangement of the source in the cones we approach this ideal condition; but, nevertheless, certain rays are emitted at a small angle to the surface of the cone, giving rise to a penumbra around the "geometrical" beam. With our cones the penumbra effect would be a function of the periphery of the conical base, therefore, it would be a different proportion of the total beam with conical beams of different solid angle. Furthermore, one must consider also the effect of secondary and scattered rays emerging from the lead walls of the cones. With cones of three different apertures it is possible to estimate the relative importance of the combined effect of penumbra and scattered radiation. The solid lead plug, B, permitted us to test for any radiation which might emerge from the lead block, A, since it is known that some gamma rays are capable of traversing more than 20 cm. of lead. (The lead thickness in our case was 20.9 cm. and it was found that the radiation transmitted was negligible.)

3. *Ionization Chamber and Measuring Instrument.*—Our large ionization chamber used for "standard" X-ray measurements was also used for the gamma-ray measurements. It was described in detail some time ago (12) and is shown diagrammatically in the upper part of Figure 6. It will be remembered that this is a large chamber with two parallel plate electrodes 22×42 centimeters. The plates are mounted on screws and the spacing can be varied at will from 4.6 to 24 centimeters. One electrode is made up of 11 aluminum strips 3.8×22 cm., arranged in the same plane and separated from one another by air gaps of 0.25 millimeter. Each strip is supported by separate amber insulators and can be used as an electrode independently of, or in combination with, any others. Thus the relative sizes of the "collecting" or master electrode and its guard plates may be varied at will. For the gamma-ray measurements the ionization chamber was mounted vertically above the lead cylinder, as shown in Figure 6. The center of the chamber was at a distance of 60 cm. from the radon tube. The beam of radiation produced by the large cone passed through the chamber without striking any part thereof. (The electrode spacing shown in the figure is 15 centimeters.) Batteries were used to provide the voltage for the chamber, and it was found that 1,000 volts was well above the saturation value for the radiation beams we used.

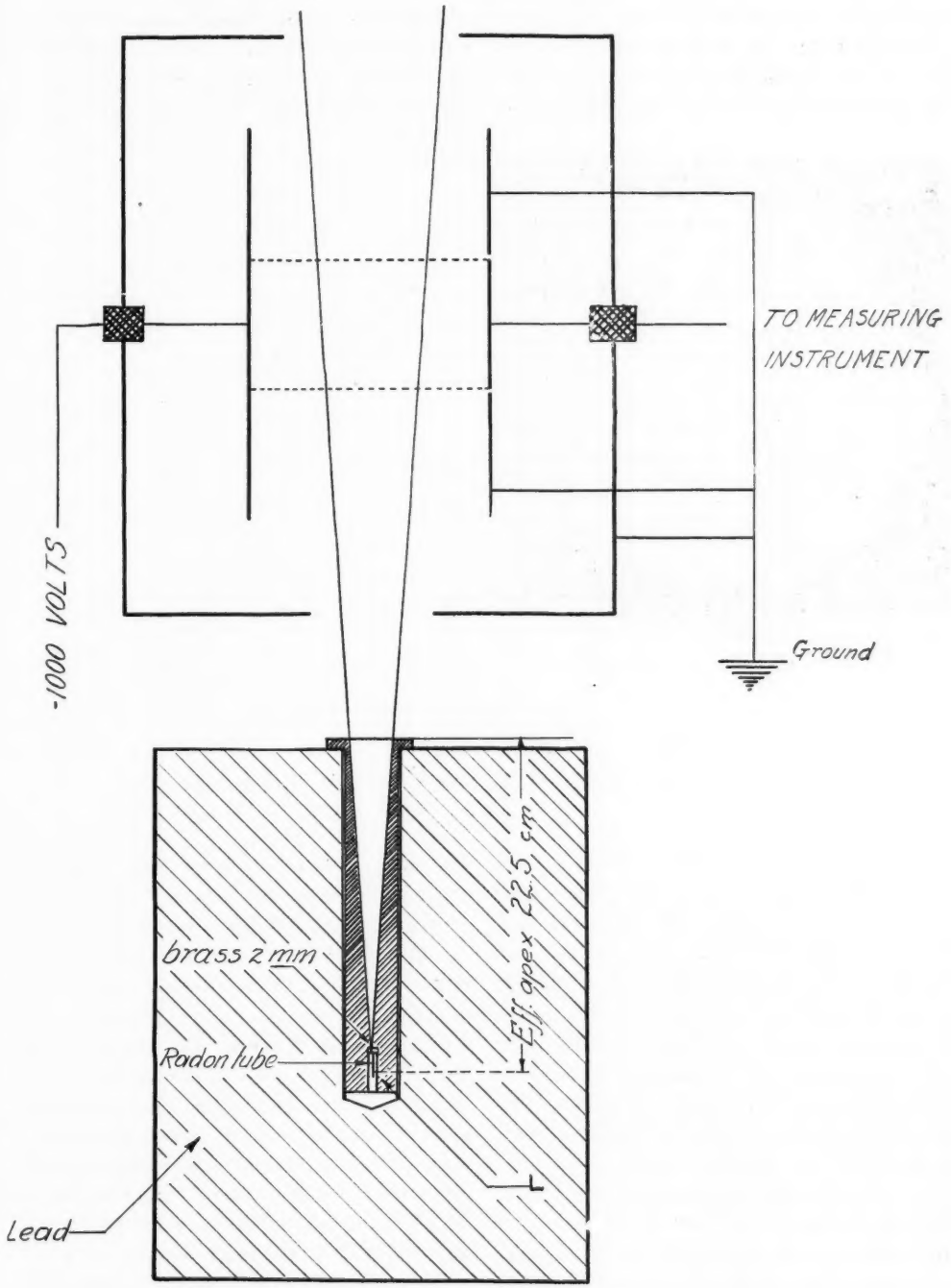


Fig. 6. Set-up for the measurement of gamma rays in terms of roentgens.

The ionization current was measured by means of the vacuum tube device previously described (13). In this case, however, it was found necessary to use either a two-stage amplifier with screen grid tubes, or a single special vacuum tube.[1] Most of the measurements were made with the latter tube, which is capable of detecting extremely small currents. The circuit of the measuring device is shown in Figure 7. It will be noted that the vacuum tube is used only as a detector of balance between the current produced in the standard chamber, A, and the radium chamber, B. Accordingly the readings are independent of the characteristics of the vacuum tube.

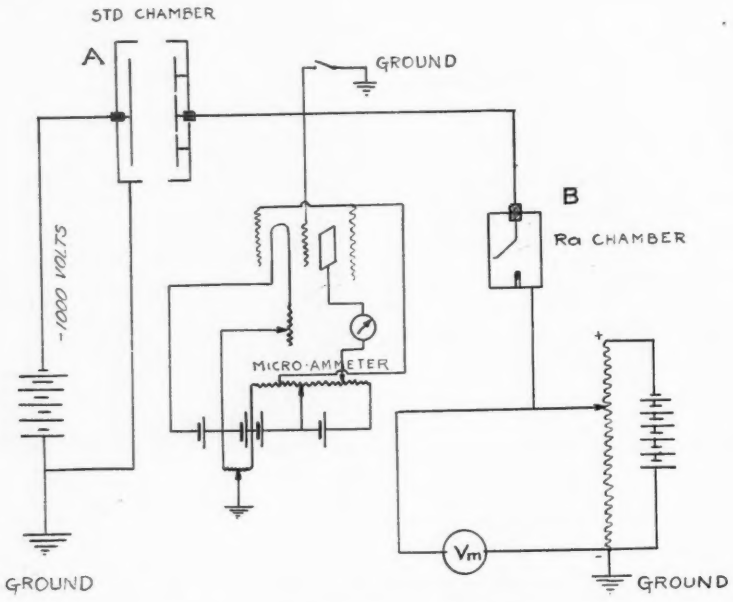


Fig. 7. Diagram of vacuum tube instrument used to measure the ionization current.

Since the radium chamber, B, is the most important part of the measuring device, it may be well to describe it in detail. Its construction is shown in Figure 8. It is made up of a brass cylinder 8.3 cm. in diameter and 8.3 cm. high, at one end of which is a brass "neck" supporting the inner electrode, E, by suitable insulators and a guard ring, as shown. The main insulation is provided by amber. Since during operation electrode E is always practically at ground potential, there is no possibility of current leakage. At the other end of the brass cylinder is provided a receptacle for a small glass tube containing 1.5 mg. of radium. The radium salt in this tube fills practically the whole space and the tube is attached to the metal receptacle by means of De Khotinsky cement. In this way the radio-active source is in a fixed position with regard to the chamber. The ionization produced in the air of the chamber is largely due to the beta rays emitted by the radium source.

By applying a certain voltage to the outer electrode of this chamber an ionization current is produced which may be used to com-

[1]This is now known as Vacuum Tube FP-54.

pensate the current to be measured. With any given chamber and radium tube, the current depends only on the applied voltage. (If the chamber is not sealed air-tight a correction for pressure and temperature of the atmosphere must be made.) It is thus possible to calibrate a chamber of this type so that, knowing the value of the voltage applied, one knows the magnitude of the current produced. Theoretically it makes no difference what the mathematical relation between the voltage and current is, but in practice it is desirable to have as nearly a straight line relation between the two as can be obtained conveniently. It is for this reason that the inner electrode, E, of the chamber was curved in the shape shown, the object of the curvature being to concentrate the electrostatic field at a point some distance away from the radium tube, in the immediate vicinity of which the maximum ionization is produced. With this arrangement a much higher voltage is required for saturation and the relation between applied voltage and current is nearly linear, over a considerable voltage range. This may be seen from Figure 9.

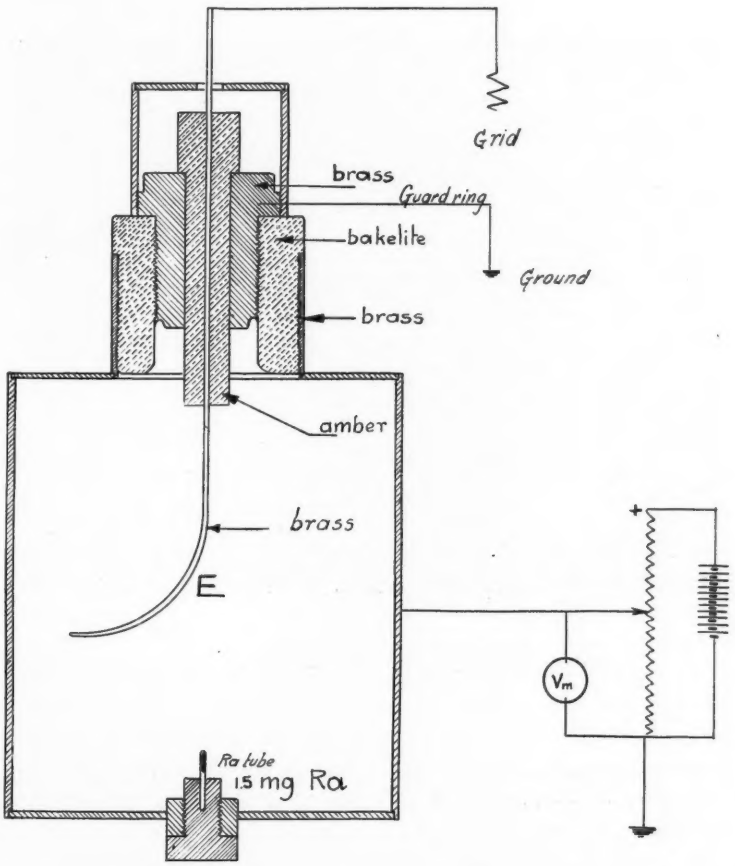


Fig. 8. Design of radium compensating chamber.

At this point it may be well to mention the

provisions made for shielding of the measuring apparatus. Referring to Figure 6 again, it will be seen that the radon tube used as a source of gamma rays was essentially in the center of the large lead cylinder; radium. The amount of radiation scattered back from the ceiling into the chamber or instrument was found by actual test to be negligible. Accordingly no additional lead shielding of the apparatus was necessary.

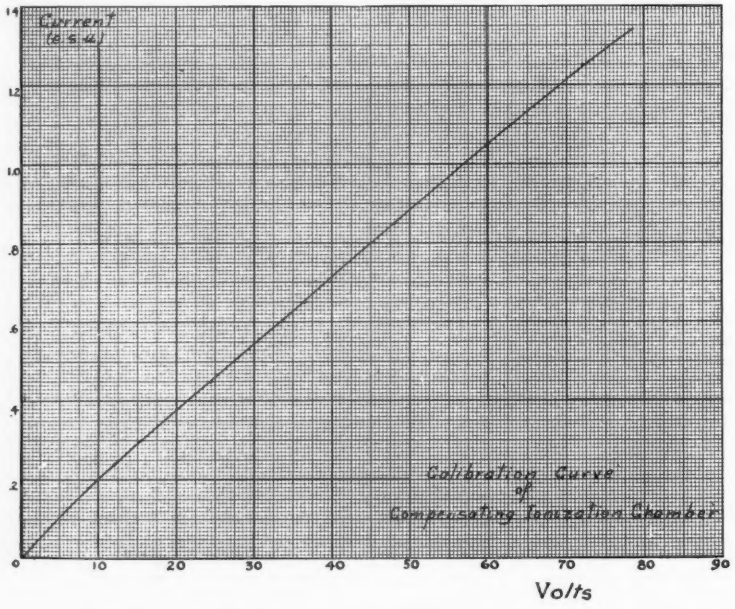


Fig. 9. Calibration curve of compensating chamber.

accordingly any "stray" radiation from the source would have to traverse about 18 cm. of lead. Furthermore, the measuring instrument was placed at a distance of about 160 cm. from the ionization chamber (and the radon tube). This provided sufficient screening for the instrument with its radium chamber. The solid lead plug of Figure 4 enabled us to test this point as well as the effect on the standard chamber of the "global" radiation through 20.9 cm. of lead. Both were found to be negligible. The useful gamma-ray beam was projected upwards, passing through the ionization chamber without striking it, and finally impinging on the ceiling of the room, 300 cm. above the The electrical system, however, being very sensitive, had to be shielded electrically with some care.

4. *Calibration.*—It will be remembered from the discussion of Section 1 that the current through the standard ionization chamber must be known in electrostatic units in order to determine the intensity of the radiation beam in roentgens per minute. With our method of measurement it is necessary only to calibrate the radium compensating chamber (Fig. 8) in electrostatic units. An important advantage of the design of compensating chamber shown is that the calibration, once made, remains constant. However, on account of the small current

values involved, special precautions must be taken when the calibration is determined. For this reason the experimental procedure employed will be described somewhat in detail.

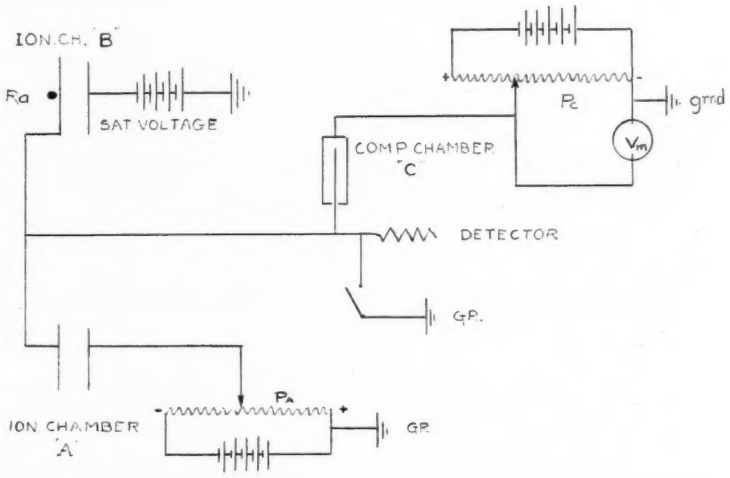


Fig. 10. Diagram of method used for the determination of the calibration curve.

The *shape* of the calibration curve of Figure 9 was determined as follows.[2] In Figure 10 there are three ionization chambers connected to the balance detector (grid of vacuum tube) of the measuring instrument. One of these chambers, C, is the compensating chamber to be calibrated. Chamber A is similar to C (for convenience) and is provided with a potentiometer, P_A, so that the current through it may be varied at will by adjusting the voltage applied to it. Chamber B is any suitable ionization chamber which, in conjunction with a radium tube, Ra, produces a saturation current which is small in comparison to the maximum current for which C is to be calibrated. The three ionization chambers are far enough apart, or are properly screened by lead, to avoid any appreciable influence of the radium in one upon the others. The radium tube of chamber B can be removed and replaced in the *same position* at any time.

With no voltage applied to chambers A and C, and no radium on chamber B, the zero reading of the instrument is taken. The radium tube is now placed in chamber B and the system is balanced by applying a certain voltage to chamber C. The current through both of these chambers is the same, but its magnitude is unknown. We know, however, and we record, the voltage which had to be applied to chamber C in order to establish balance in the system. We now remove the radium from chamber B and restore the balance by applying a certain voltage to chamber A, *without disturbing C*. The current through chambers A and C is the same, but no current flows through B since the radium tube has been removed. The electrical system is properly balanced and can be used as if no current flowed through the chambers A and C. By replacing the radium upon chamber B we produce in it the same current as before, although its magnitude is still unknown. Balance may

[2]This method was devised by Mr. Marinelli, of our laboratory.

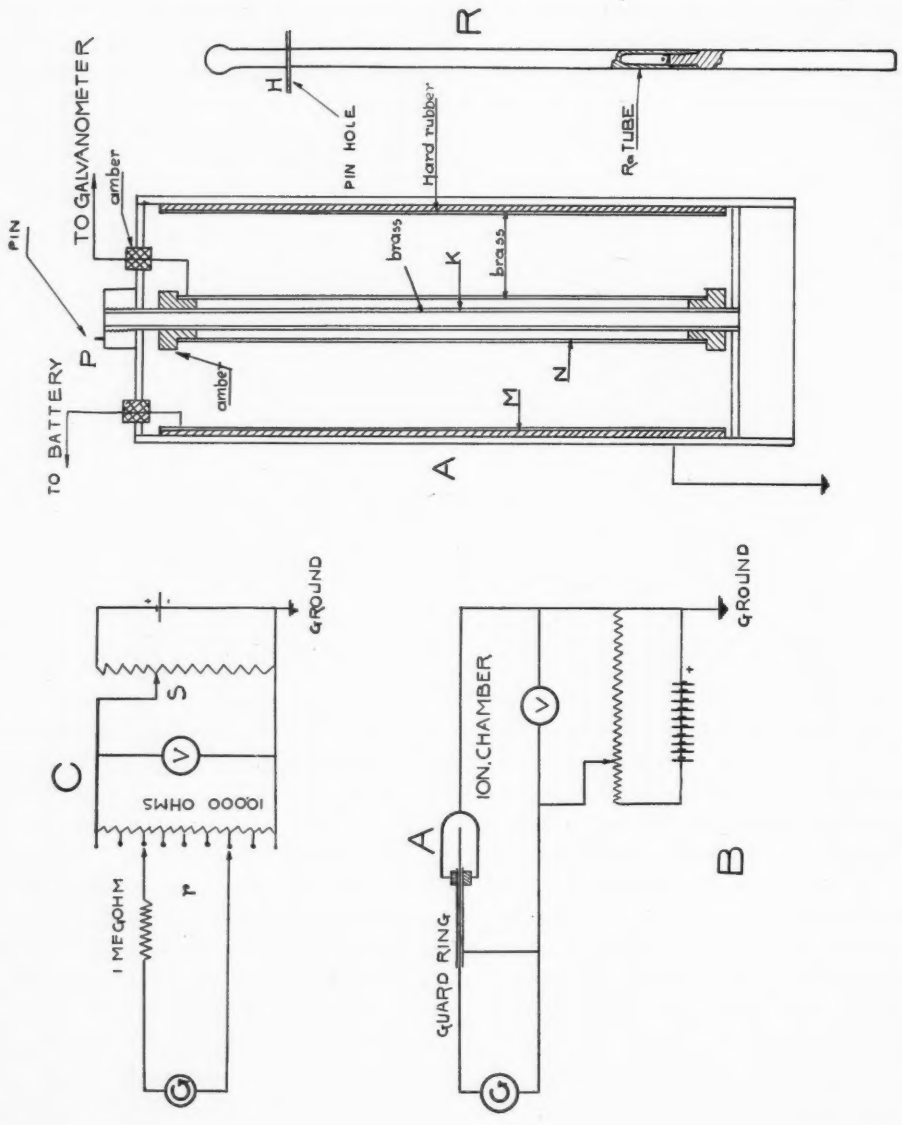


Fig. 11. Diagram of method used for the calibration of the compensating chamber in electrostatic units.

be re-established by increasing the voltage on C. When this has been done, the current passing through C is exactly twice the current produced in B by the radium tube. We know, therefore, what increase in the voltage applied to C is necessary to double the current through it. By repeating the procedure just described, one can determine the voltage to be applied to C in order to produce any multiple of the constant (but unknown) current of chamber B with the given radium tube in place. Therefore, we can establish the relation between applied voltage and current for the compensating chamber C in equal current increments without knowing the actual magnitude of the current. This

gives the *shape* of the calibration curve. It is necessary now only to determine the absolute value of the current for *any one point* on the curve and the arbitrary scale can be translated immediately into the desired current units.

Before describing this part of the calibration procedure, it might be well to point out certain advantages of the scheme just described. It is evident that the current increments may be made as small as desired, thus determining a large number of points through which the curve is finally drawn. This can be done most easily by choosing a radium tube of some suitable strength and adjusting the thickness of lead filter to control further the ionization in chamber B. Furthermore, the sensitivity of the measuring device is the same at each step; hence the shape of the curve can be determined in a simple manner with any degree of precision desired. Only one tube of small radium content (a few milligrams) is required for this purpose. (Since in our laboratory we have always available radon tubes ranging from 5 to 250 millicuries, the shape of the curve can be determined easily by omitting chamber A in Figure 10 and placing successively upon chamber B radon tubes of increasing strength. The ionization current will be proportional to the millicurie value of each tube, and the relation between voltage applied to chamber C and millicuries on B will give the *shape* of the calibration curve. This is the method employed at first.)

The current for which our radium compensating chamber was designed is of the order of one electrostatic unit, too small to measure with the highest sensitivity galvanometer available, yet it is of great advantage to use a galvanometer for the determination of the absolute value of the current. For this reason we used the following scheme to overcome the difficulty. We constructed an ionization chamber as shown at A in Figure 11. It consists essentially of two coaxial cylindrical electrodes, M and N, suitably insulated. A brass tube, K, is supported

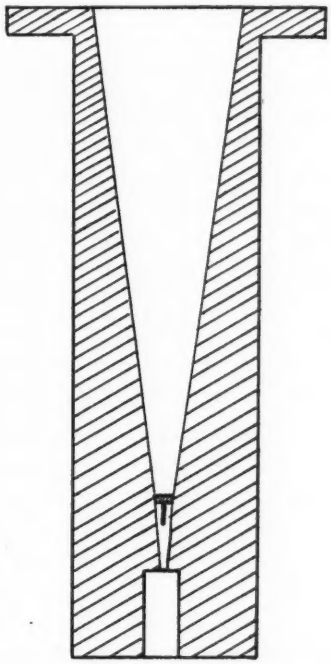


Fig. 12. Test for the "visibility" of the gamma-ray source through a lead cone.

along the axis of the chamber so that a rod, R, can be inserted into it at any time. This rod has a receptacle just large enough to house a tube of 50 mg. of radium. When the rod is slid into the tube, K, the hole, H, registers with pin, P, in the ionization chamber. In this way the radium tube is brought always to the same depth and has the same orientation in the ionization chamber. (The radium tube is kept permanently in rod, R.) The volume of the chamber is such that the saturation current produced by 50 mg. of radium can be measured easily with a Leeds and Northrup high sensitivity galvanometer. Other rods similar to R have been provided with radium tubes of 1, 5, and 10 mg., respectively. If the tubes were all identical in size and filtration, it is evident that the ioni-

zation currents produced by them would be in proportion to their radium content. Hence, having measured the current in the case of the 50 mg. tube, the current produced by the 1 mg. tube would be just one-fiftieth that of the former.

Since the tubes differ considerably in construction, this could not be done without applying the necessary corrections. In our case, it was simpler to place in a rod, similar to R, a tube containing about 50 millicuries of radon (the exact amount need not be known) and to use this source to produce the ionization current to be measured with the galvanometer. Since the disintegration rate of radon is accurately known (16.4 per cent in 24 hours), the current which the same tube would produce at any subsequent time can be calculated easily. Thus by making measurements at the proper time intervals it is possible to cover the current range from the initial value to zero, by using the same geometrical source. In our case the radon had to decay to about 5 mc. before the current reached the range of our compensating chamber. After this, the chamber of Figure 11, with the radon tube in place, was connected to the measuring instrument and its current was balanced in the usual way by the radium compensating chamber.

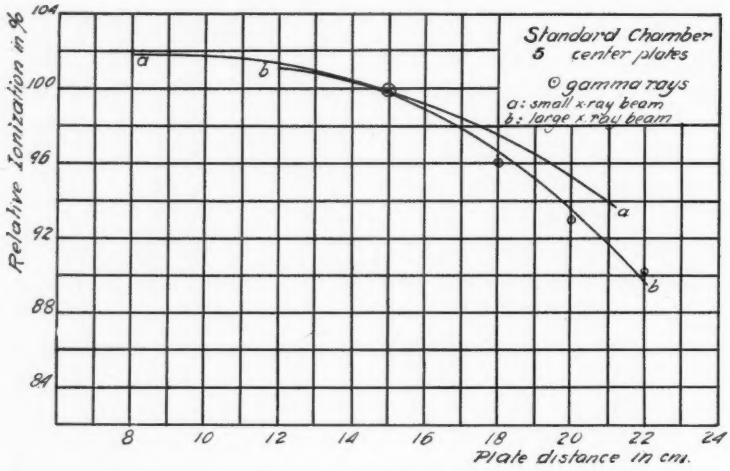


Fig. 13. Influence of field distortion in the standard chamber.

The magnitude of the current was calculated from the initial value and the elapsed time. This was repeated several times until the current became too small to balance properly. It is interesting to note that the points obtained in this way from day to day coincided almost exactly with the curve previously determined by a different method.

A substitution method was used to determine the magnitude of the current registered by the galvanometer. First, the galvanometer was connected in series with the ionization chamber A (see B, Fig. 11), containing the radon tube. The current flowing through the system produced a certain deflection (about 11 cm.), which was carefully noted. The galvanometer was then connected to the circuit shown at C of Figure 11, and the slider, S, was adjusted until the same galvanometer deflection as before was obtained. The reading of the voltmeter, V, and the values of the resistances in paral-

lel and in series with the galvanometer, determine the magnitude of the current through the galvanometer. Several such determinations were made at intervals during the period in which the radon tube produced a large enough current to be measured by the galvanometer. In every case after the first measurement a close agreement was found between the new reading and the one calculated from the decay rate of radon.

Great care was exercised in making the connections of circuit C of Figure 11, to avoid leakage currents. The resistances involved in the calculation of the current were known accurately. The voltmeter, V, was calibrated against a standard cell by means of a Leeds and Northrup potentiometer. Thus in spite of the several steps in the process of determining the calibration curve of our radium compensating chamber, we can say that its accuracy is considerably higher than is required in work of this sort. A recent comparison of the same radium chamber with the measuring system used at the Bureau of Standards shows an agreement within 1 per cent throughout the useful range of the curve.

5. *Measurement of Gamma Rays in Roentgens.*—With the ionization chamber placed above the lead cylinder in the relative position shown in Figure 6, and about 800 mc. of radon in one of the cones, preliminary tests were made. From these it was evident that the spacing of the electrodes should be about 15 centimeters. It was found also that the collecting electrode of the chamber had to be quite wide in order to get a current which could be properly balanced by our radium compensating chamber. It will be remembered from the construction of our standard chamber that the collecting electrode is made up of parallel strips which can be connected together. In subsequent experiments, therefore, three or more of these strips were used, making the width of the electrode 11.48 or more centimeters.

In view of the small diameter of the cones directly over the gamma-ray source and the length of the radon tube, it was thought desirable to test experimentally whether every point of the source was within the geometrical prolongation of the cone to its apex. This was done by taking readings with the radon tube in its normal position and in the position shown in Figure 12. For this purpose the capillary glass tube was attached at one end to the brass filter, which was then lowered into the cone. Readings taken with the source in this position were higher than those obtained with the tube in the fiber cylinder below the small end of the cone, but the increase was substantially as calculated by the inverse square law, for a source closer to the aperture of the conical diaphragm.

Measurements were made at intervals extending over a period of several months. The results obtained were always very different from those reported in the literature (obtained by indirect means), no matter what modifications and allowances were made. The experimental results are given in Table I. Each group represents measurements made at one time. The last ones were made with the greatest care, and are, therefore, the most reliable ones. It is interesting to note that in spite of appreciable variations in the preceding results, the average is very close to the last ones. The gamma-ray emission under the geometrical conditions of the experiment and with a filter of 2 mm. of brass, is 0.00108 electrostatic unit per cubic centimeter per gram of radium. Since in the definition of the roentgen a temperature of 0° C. is specified, and our measurements were made at room temperature of approximately 22° C., it is necessary to take this into account in calculating the emission in roentgens per minute. The correction factor is $\frac{295}{273} = 1.08$, or 8 per cent. Therefore,

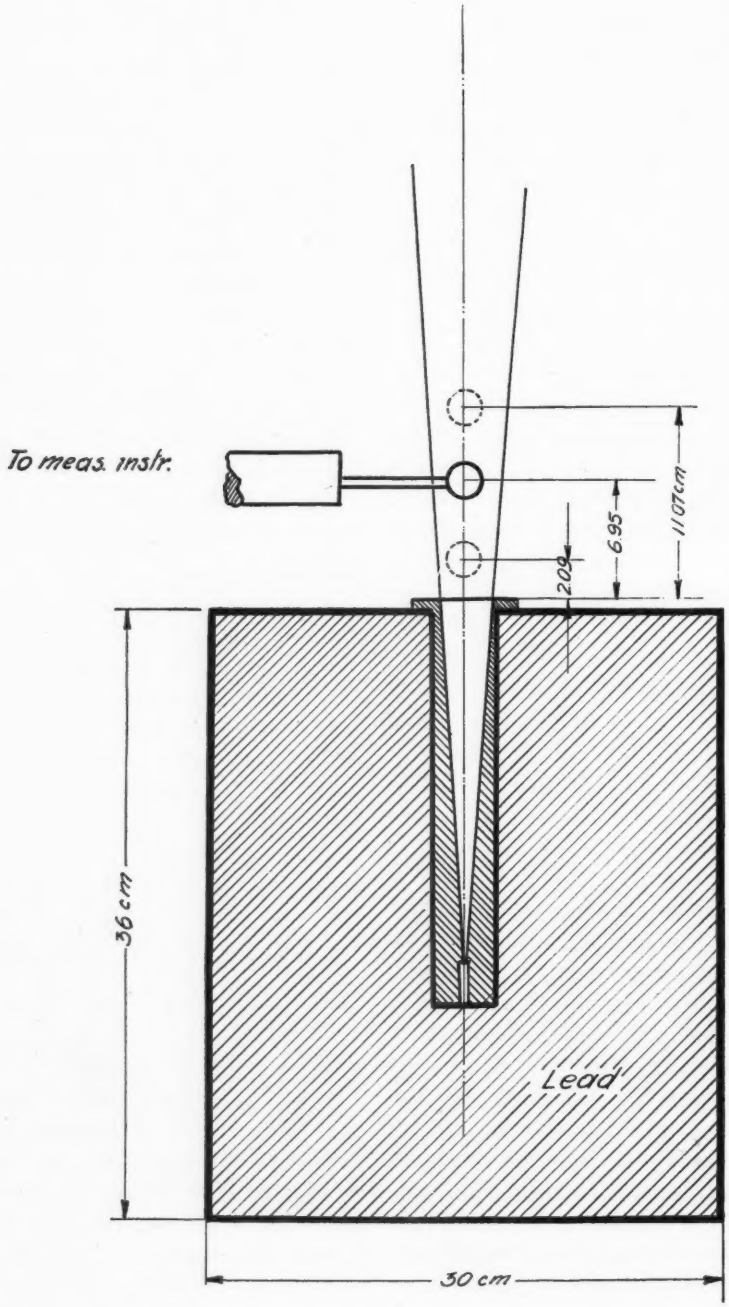


Fig. 14. Set-up for calibration of spherical lead chamber.

TABLE I

MEASUREMENT OF GAMMA RAYS WITH STANDARD CHAMBER

Cone	Ionization chamber setting		Volume (c.c.)	Current (e.s.u.)	Strength of source (mc.)	Electrostatic unit per c.c. per gram Ra
	Distance of electrodes (cm.)	Width of collector (cm.)				
Large	10	4.93	25.8	0.0227	807	0.00109
Large	15	19.13	100.0	0.0696	612	0.00113
Large	15	11.48	60.0	0.0401	612	0.00109
Medium	15	11.48	30.3	0.0197	612	0.00107
Small	15	11.48	13.3	0.0091	612	0.00112
Large	10	19.13	100.0	0.0772	711	0.00108
Large	10	11.48	60.0	0.0454	711	0.00108
Large	15	11.48	60.0	0.0467	695	0.00112
Medium	15	11.48	30.3	0.0217	695	0.00103
Small	15	11.48	13.3	0.0095	695	0.00103
Large	15	26.78	140.0	0.1190	736	0.00115
Medium	15	26.78	70.7	0.0540	736	0.00104
Small	15	26.78	31.3	0.0233	736	0.00101
Large	15	11.48	60.0	0.0552	808	0.00114
Medium	15	11.48	30.3	0.0258	808	0.00105
Small	15	11.48	13.3	0.0114	808	0.00106
Large	15	19.13	100.0	0.0994	920	0.00108
Medium	15	19.13	50.5	0.0504	920	0.00108
Small	15	19.13	22.2	0.0220	920	0.00108

Average	0.00109
Adding 2 per cent for field distortion	0.0011

the emission in terms of the roentgen is 0.070 r per minute per gram.

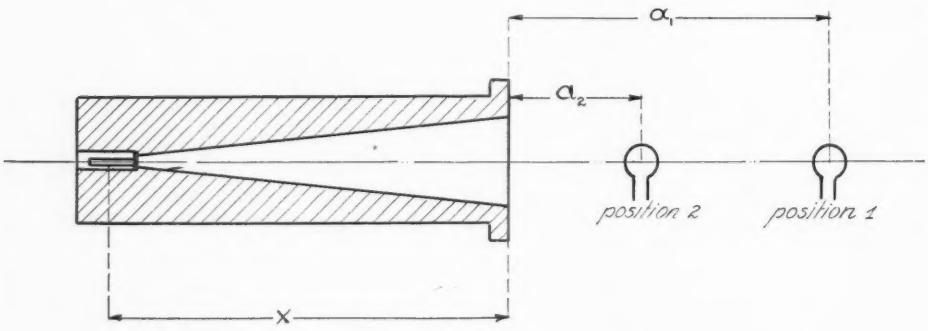
We have already mentioned the reason for providing three cones of different apertures for these experiments. From the last column of Table I it will be seen that in general the large cone gave higher readings than the two smaller ones. It is difficult to say, however, whether the difference is really significant. The last experiments, which were performed under more nearly ideal conditions, do not show this difference. At any rate it is evident that no serious spurious factors were introduced by the arrangements chosen for the production of well-defined beams of gamma rays.

We must consider now the requirement of "complete utilization of the secondary electrons" in the definition of the roentgen. Gamma rays produce secondary electrons which are capable of traversing several meters of atmospheric air. Theoretically, therefore, the ionization chamber should have the dimensions of a large room. Our chamber, of course, is much smaller, and so it becomes necessary to estimate what error is introduced by this factor.

From previous experiments we know the distribution of the electrostatic field in our standard chamber, for different sizes of collecting electrodes and different distances between electrodes. Referring to these (published) data (12) it will be seen that the field under the collecting electrode is not quite uniform when the spacing is greater than 15 cm., even if only the central strip of the composite electrode is used. To determine the correction for field distortion

under the conditions of the gamma-ray measurements, the following test was made. A narrow beam of X-rays was passed through the chamber with the five center plates acting as collecting electrode. A voltage high enough for complete saturation with the greatest spacing was applied. Ionization readings were then taken for different spacings up to 22 cm., the results being shown by curve a of Figure 13. Then an X-ray beam of approximately the same diameter as the largest gamma-ray beam used was passed through the chamber and again readings were taken for different distances between electrodes. Curve b of Figure 13 was thus obtained. The circles in the same figure represent the readings obtained when the same experiment was performed with the large conical beam of gamma rays traversing the chamber.

It will be seen that in the case of the small X-ray beam the ionization remains practically constant until the electrode separation reaches about 11 cm., and then decreases gradually, this decrease being an indication of the effect of field distortion. With the large X-ray beam the effect (curve b) is more marked. But it is important to note that the points (circles) for the corresponding gamma-ray experiment fall very close to this curve. From this we may infer that the ionization produced by the gamma-ray beam is largely confined within the geometrical beam, as in the case of X-rays. This conclusion is supported by the autophotograph of the beam shown in Figure 5, although there is evidence in the original film of soft radiation outside the cross-section of the beam proper. At any rate it is certain that there is no appreciable increase in ionization when the electrode spacing is increased from 15 to 22 cm., accordingly it is difficult to see how the ionization would be materially increased by increasing the electrode separation to the theoretical limit of several meters. In this connection it



by inverse square relation

$$X = \frac{a_1 - a_2\sqrt{\frac{I_2}{I_1}}}{\sqrt{\frac{I_2}{I_1}} - 1}$$

where: I_1 = ionization current for pos 1

I_2 = " " " " " " 2

Fig. 15. Determination of "effective" distance of gamma-ray source.

should be remembered that the ionization of air by gamma rays is due very largely to the process of scattering (Compton effect), most of the ionization being produced by "recoil electrons." These electrons do not travel very far in atmospheric air unless the radiation which gives rise to them is of extremely short wave length. The gamma radiation of radium filtered by two millimeters of brass still has a considerable proportion of the softer components of the emitted rays; nevertheless, the average wave length is much shorter than ordinary X-rays and some recoil electrons (as well as the photo-electrons) must be capable of traversing several meters of air. These high speed electrons do not produce much ionization per centimeter of air until their velocity has been reduced considerably; therefore, it is very difficult to make a reasonable estimate of their contribution to the ionization in the standard chamber. This problem is being investigated further.

By referring again to Figure 13 it will be seen that a correction for field distortion in the chamber must be made. According to the curve for the small X-ray beam, the ionization for a 15 cm. electrode spacing is about 2 per cent less than the constant value for spacings between 8 and 11 cm.; therefore, the gamma-ray emission determined with the chamber under comparable conditions must be increased by this amount. The corrected value is 0.071 r per minute per gram of radium.

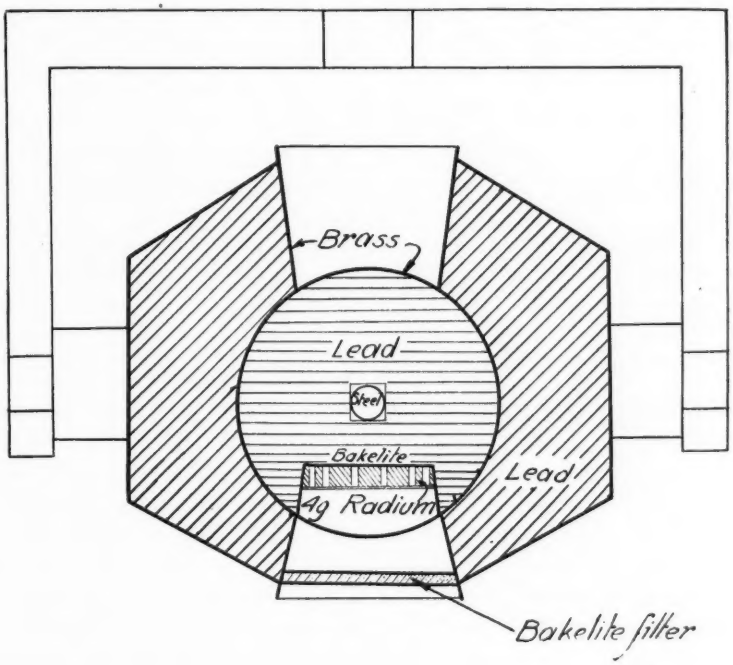


Fig. 16. Cross-section of radium "pack."

The above figure refers to a point at the mouth of the lead cones, just as in the case of X-rays the measurement with the standard chamber refers to the intensity at the point where the diaphragm is located. On

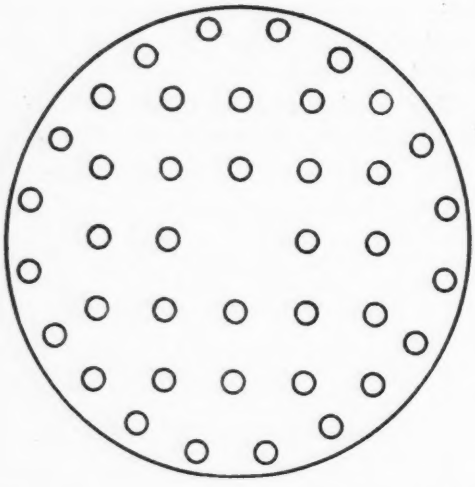


Fig. 17. Distribution of radium tubes in the pack.

account of the appreciable length of the gamma-ray source used in these experiments (12 to 14 mm.), it is desirable to determine experimentally the effective apex of the cone. For this purpose the arrangement shown in Figure 14 was used. S is an approximately spherical ionization chamber 1.9 cm. in diameter, made of lead 1 mm. thick, connected, when in use, to the vacuum tube measuring device by means of a flexible cable. It could be placed, then, at different distances above the large lead cone, in the path of the gamma-ray beam. Taking readings with this chamber in two different positions in the beam, it is possible to calculate the effective apex of the cone, or, in other words, the position of the equivalent point source, with respect to the aperture of the lead cone. The method of calculation is indicated in Figure 15 and the experimental results are given in Table II.

In this manner the average distance of the theoretical point source from the mouth of the cone was found to be 22.5 cm.: by actual measurement the geometric center of the radon tube was 22.1 cm. below the mouth of the same cone. Neither of these

TABLE II

A_1 (cm.)	A_2 (cm.)	I_1 (e.s.u.)	I_2 (e.s.u.)	X (cm.)
14.9	4.0	0.011	0.0222	22.3
17.1	2.8	0.0091	0.0222	22.4
7.0	2.1	0.0183	0.0262	22.8
11.1	7.0	0.0140	0.0183	22.4
11.1	2.1	0.0140	0.0262	22.5

Average..... 22.5

Measured 22.1 cm. to center of radon tube

two values is strictly correct, but the close agreement between the two serves as further justification of the use of the lead cones and radon tube in the measurement of gamma rays with a standard chamber. The error introduced by taking one or the other of the above values is less than 4 per cent: the one experimentally determined is probably closer to the correct one and, therefore, we shall use this in our calculations. We may say, then, that one gram of radium filtered by 2 mm. of brass emits gamma rays at such a rate that the intensity at a distance of 22.5 cm. is 0.071 r per minute. For purposes of calculation the gamma-ray emission should be given for a one-centimeter distance from a point source. The value is 36 r per minute per gram at one centimeter.

6. *Measurement of the Gamma-ray Emission of a Radium "Pack."*—At the Memorial Hospital we have a large radium "pack" containing 4 grams of radium which is used extensively for therapeutic purposes. It is of interest, therefore, to measure the gamma radiation emitted by this appliance with the idea of expressing in roentgens the quantity of radiation administered to patients. The construction of the pack has been described fully in a previous publication (14). Since, however, certain details are essential for the proper interpretation of the results, they will be repeated here.

Figure 16 shows the cross-section of the heavy lead container. The radium capsules (40 of 100 mg. each) are distributed over

a bakelite disc, 7.5 cm. in diameter, according to the pattern shown in Figure 17. It is important to note that the tubes stand on end, and that the concentration is greatest around the periphery of the circle. The capsules are made of platinum and are approximately 10 mm. high and 5 mm. in diameter, with a wall thickness of 0.35 millimeter. The bakelite disc is supported in the lead container as shown in Figure 16, so that it registers with a conical port in the lead. The center of the capsules is at a distance of 6 cm. from the brim of the port in the position shown.[3]

The beam of rays passing out of the port is filtered by a minimum of 0.35 mm. of platinum and 1.5 mm. of brass. It should be noted, however, that the effective filtration is considerably greater than this, because some of the rays in passing through the cylindrical walls of the capsules traverse a greater thickness of platinum than 0.35 millimeter. This is also true in the case of the brass filter, on account of its curvature; accordingly, it is difficult to assign a definite value to the effective filter. A disc of bakelite 6 cm. thick was placed at the mouth of the port as a secondary filter in the case of the experiments to be described here.

Since the beam of radiation emitted by the pack is too large and its cross-section is too indefinite to be measured directly with a standard chamber, the following plan was adopted. The spherical lead chamber already described can be calibrated against the standard chamber to read directly in r per minute. This can be done by first measuring a beam of gamma rays with the standard chamber and then taking a reading with the lead chamber at a definite point in the same beam. From the standard chamber reading the intensity at any point in the beam can be calculated, and, therefore, the intensity at the point where the (center of the) lead chamber was placed can be determined. This value of the intensity corresponds, then, to a certain ionization current produced in the lead chamber, and the relation between the two is established. By this method the small chamber is calibrated with radiation of the same quality as that which the chamber is intended to measure later. Accordingly, no uncertainty due to "wall effect" exists, and any material can be used for the construction of the chamber. We used a lead chamber because, for the same air volume, the current is larger, on account of the greater emission of secondary electrons by lead. A graphite chamber was also used and, as expected, the measurements agreed with those made by the lead chamber.

The small chamber thus calibrated was then placed at a definite point in the beam emitted by the radium pack and the intensity at this point was measured directly. The small size of the chamber enabled us to "explore" the beam over its cross-section and at different distances from the radium, beyond the minimum of 6 centimeters. Radiation reaching the chamber from different directions (every radium capsule) registered its full effect on the chamber, on account of its spherical shape and uniform wall thickness.

TABLE III

CALIBRATION OF SPHERICAL LEAD CHAMBER

Distance of Chamber from		Current (e.s.u.)	Strength of source (mc.)	E.s.u. per gram at 22.5 cm.
Mouth	Apex			
2.1	24.6	0.0262	815	0.0382
2.8	25.3	0.0222	743	0.0378
4.0	26.5	0.0222	794	0.0388
7.0	29.5	0.0183	815	0.0387
11.1	33.6	0.0140	815	0.0383
14.9	37.4	0.0110	794	0.0383
17.1	39.6	0.0091	743	0.0380
		Average		0.0383

[3]By rotating the lead cylinder to which the disc is attached the radiating surface can be made to register with a port on the opposite side of the container. In this position the radium is at a distance of 10 cm. from the brim.

In Table III are given the experimental data for the calibration of the spherical lead chamber. Readings taken with the chamber at different distances above the large lead cone are in good agreement when reduced to a distance of 22.5 cm. from one gram of radium. (See last column of Table III.) The average value of the ionization current produced in the lead chamber under these conditions was 0.0383 electrostatic unit. It will be remembered that the gamma-ray emission measured with the standard chamber was found to be 0.071 r/min. per gram for this distance. Therefore

$$0.0383 \text{ e.s.u.} = 0.071 \text{ r/min.}$$

or

$$1 \text{ e.s.u.} = 1.85 \text{ r/min.}$$

Accordingly an ionization current of 1 e.s.u. corresponds to a gamma-ray intensity of 1.85 r per minute.

As already stated, the calibration of the spherical lead chamber was carried out by placing it in the beam of gamma rays issuing from the large lead cone. In the discussion of the cones, reference was made to the possible influence of the mass of lead used to limit the beam. For this reason it was thought desirable to suspend the radon tube in air and then take a reading with the lead chamber at a distance comparable to the one used with the cone. To minimize as much as possible the influence of the strong radon tube on the measuring apparatus proper, since the source was unprotected in all directions, certain precautions had to be taken. A detailed description of the experimental procedure is, perhaps, unnecessary in view of the fact that all sources of error could not be eliminated completely. The test was made by determining the distance from the unprotected radon at which the small chamber had to be placed in order to get the same reading as obtained with the large lead cone. The two distances were:

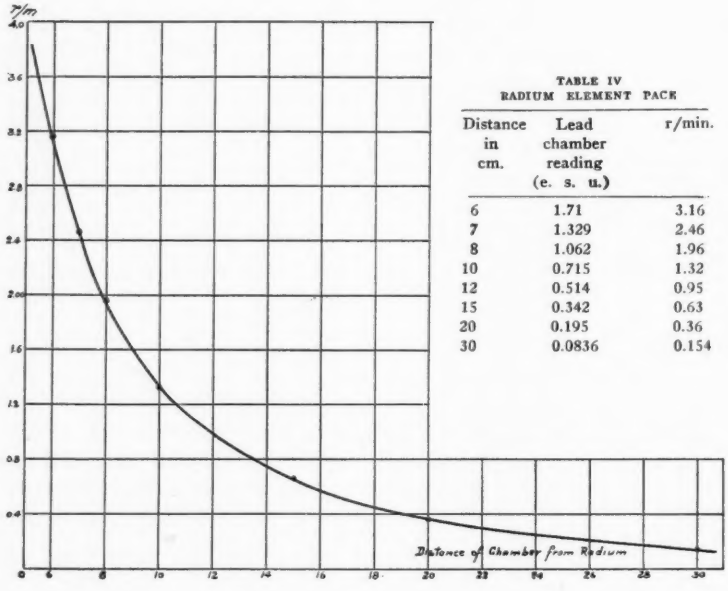


TABLE IV
RADIUM ELEMENT PACK

Distance in cm.	Lead chamber reading (e. s. u.)	r/min.
6	1.71	3.16
7	1.329	2.46
8	1.062	1.96
10	0.715	1.32
12	0.514	0.95
15	0.342	0.63
20	0.195	0.36
30	0.0836	0.154

Fig. 18. Gamma-ray emission of radium pack at different distances.

with the cone 27.6 cm.; with the radon suspended in air, 28.2 centimeters. The latter is somewhat greater and, on the basis of the inverse square relation, shows a discrepancy of 4 per cent—not unduly large considering the difficulties of the test. The increase in ionization may be accounted for by the scattered radiation in the room, due to the global radiation of the unprotected radon tubes of 800 millicuries. We may conclude from this test that any disturbances in the gamma-ray beam introduced by the presence of the lead around the source cannot be serious.

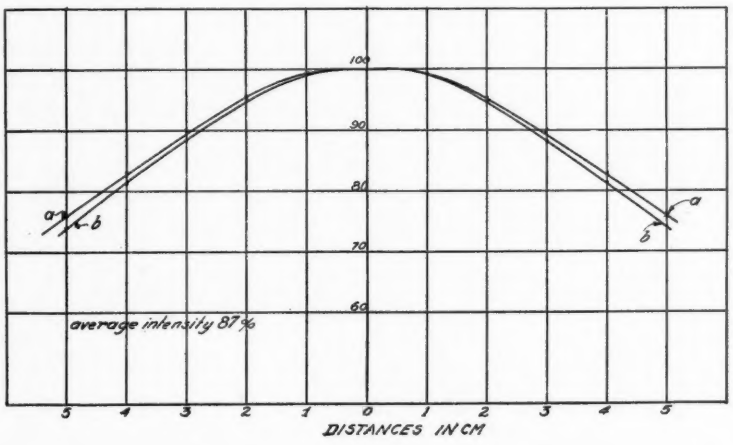


Fig. 19. Distribution of intensity in the cross-section of the beam emitted by the pack at 6 cm. level.

For the exploration of the beam emitted by the radium pack, the spherical lead chamber was placed in the center of the beam at a distance of 6 cm. from the radium, and a reading taken. Then, since the pack is equipped with a motor drive for vertical adjustments, the ionization chamber was kept in the same position and the pack was raised to different heights. Thus the distance between the radium and the chamber was varied from 6 to 30 cm. without disturbing the chamber in any way. The results are shown graphically in Figure 18 and tabulated in Table IV (inserted in the figure). They give the gamma-ray emission of the pack at different distances from the radium, expressed in roentgens per minute.

For distances which are large in comparison to the dimensions of the radiating source, it is proper to apply the inverse square relation; accordingly, we can calculate approximately the emission at different distances from the pack by using the value obtained for a point source by means of the standard chamber. (It will be remembered that this was 36 r/min. per gram at 1 cm. distance.) The measured and calculated intensities at distances from 10 to 30 cm. are given in Table V, the agreement between the two being almost perfect for the longer distances. As a matter of fact, however, the measured intensities should be somewhat lower than the calculated ones, on account of the greater filtration of the radium in the pack. Evidently the decrease in intensity due to the thicker filter is compensated for almost exactly by the scattered radiation which is produced in

TABLE V

Distance (cm.)	Intensity in r/min.	
	Measured	Calculated
10	1.32	1.44
12	0.95	1.00
15	0.63	0.64
20	0.36	0.36
30	0.154	0.160

the lead walls of the port in the pack. Considering the geometric relation between the radium tubes and the walls of the port, it is apparent that a considerable amount of scattered radiation must be present in the beam. We might estimate the decrease in intensity due to the greater filtration of the pack to be about 10 per cent, and therefore the scattered radiation must be about the same percentage.

The beam emitted by the pack was also explored in a plane parallel to the radiating surface, at the 6 cm. distance, by moving the spherical lead chamber in a horizontal plane across the mouth of the port, in two directions at right-angles to each other. The results, plotted in percentage of the intensity at the center of the field, are given in Figure 19. The point of maximum intensity (the center) was located for both curves by taking readings from one side of the beam to the other. Averages of corresponding readings were used in plotting the curves.

It will be seen that the intensity is not uniform over the cross-section of the beam, the variation being from 100 per cent at the center to 78 per cent and 74 per cent, respectively, at two points on the periphery, 90 degrees apart. When the whole beam is to be utilized it is necessary, therefore, to take this into account. An average intensity for the whole cross-section at the level explored was calculated to be 87 per cent of the maximum, or 2.75 r per minute.

When the pack is used for therapeutic purposes, the radiation at the level of the patient's skin is augmented by the radiation scattered back by the patient's body. While it is known that for gamma rays this effect is not large, it is, nevertheless, of sufficient magnitude to be taken into account. Experiments were made, therefore, to obtain a fairly close estimate of "back scatter."

Since it is known that this scattered radiation is much softer than the primary beam, it was thought desirable to make the measurements with a chamber of low absorption, and for this purpose a spherical chamber similar to the lead one was constructed of very thin celluloid. Readings were then taken with this chamber half submerged in a tank of water in the path of the gamma-ray beam, an earthenware tank 31 cm. in diameter and 38 cm. in depth being used. The celluloid chamber was also used without the water tank in order to determine the percentage of radiation scattered back by measurements made with the same chamber. The results are given in Figure 20.

The dotted curve was obtained from measurements with the lead chamber and is reproduced here for purposes of comparison; the triangles represent the results obtained under analogous conditions (ionization chamber in air) with the celluloid chamber; the solid curve is for the measurements with the celluloid chamber at the surface of the water. It may be pointed out, first, that readings taken with the celluloid chamber fall almost exactly on the curve obtained from measurements with the lead chamber, under identical conditions. Then it is evident that the scattered radiation is not a negligible fraction of the primary beam. The data of Table VI (included in Figure 20), derived from the curves, show in addition that the scattered radiation increases rapidly at first and then slowly with the distance from the water at which the pack is placed. This is, of course, to be expected on account of the fact that the volume of water irradiated increases with

the distance. The circles on the curve indicate the experimental points. No readings could be taken at the 6 cm. distance because of space limitations when the tank was in place; the value for this distance given in the table was obtained by extrapolation and, therefore, is somewhat uncertain. It will be seen, however, that this is sufficiently close for our purposes. The estimated intensity at the surface of the water, in the center of the irradiated field, is, therefore, 3.5 r per minute at the 6 cm. distance.

No experiments were made to determine the distribution of radiation at the surface of the water over the entire field. An estimate of the average intensity can be made from the data given in Figure 19. It will be remembered that the average intensity at the 6 cm. level in air was calculated to be 87 per cent of the maximum intensity in the beam; for our purposes it is proper to use the same ratio between the maximum and average intensities at the surface of the water. Hence we may say that the average intensity with back scattering at 6 cm. from the radium is 3.15 r per minute.

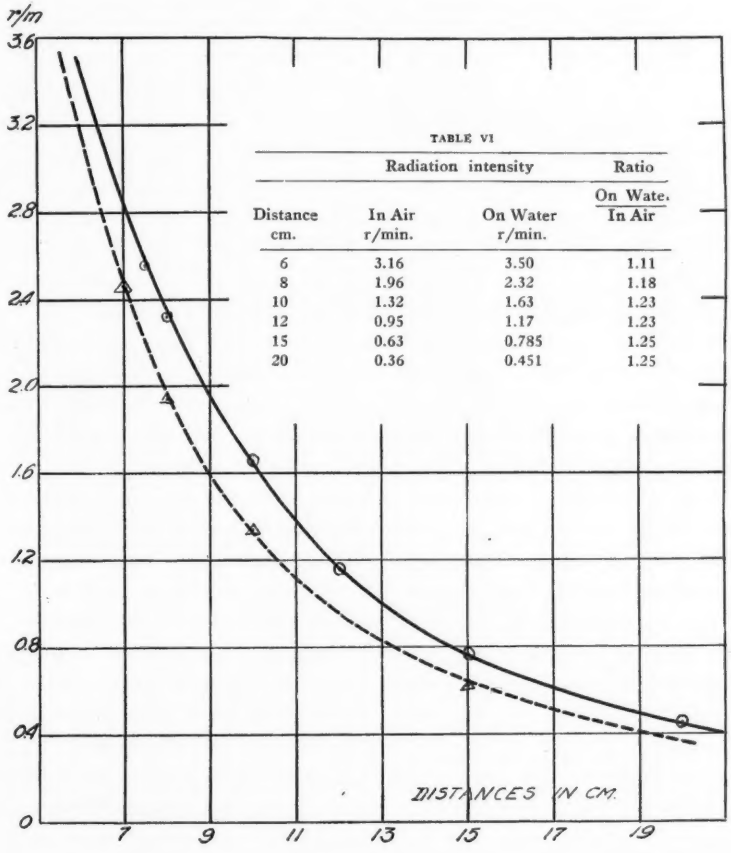


TABLE VI

Distance cm.	Radiation intensity: In Air r/min.	Radiation intensity: On Water r/min.	Ratio: On Water / In Air
6	3.16	3.50	1.11
8	1.96	2.32	1.18
10	1.32	1.63	1.23
12	0.95	1.17	1.23
15	0.63	0.785	1.25
20	0.36	0.451	1.25

Fig. 20. Gamma-ray emission of radium pack at different distances, including back scattering.

TABLE VII

GAMMA-RAY EMISSION OF PACK

Distance (cm.)	With graphite chamber r/min.	With lead chamber r/min.	Ratio
6.5	2.82	2.77	1.02
7.0	2.58	2.47	1.04
8.5	1.84	1.77	1.04
10.0	1.39	1.32	1.05

At this point it may be well to report certain tests made with a spherical graphite chamber, kindly given to us by Dr. Otto Glasser some years ago, and which has been used extensively for X-ray measurements. The ionization current of this chamber is measured by means of a quartz fiber electrometer to which it is attached through a flexible amber cable. Two methods of calibration were employed: (1) By placing the graphite chamber in a beam of gamma rays of known intensity, as for the calibration of the lead chamber; (2) by placing the chamber in an X-ray beam of known intensity, according to the usual procedure. The instrument was then used to determine the gamma-ray emission of the pack. On account of the great thickness of lead present between the radium and the electrometer, the "blank" leakage of the instrument was negligible in all cases. The calibration of the graphite chamber with gamma rays gave us the relation 1 division per minute = 0.383 r per minute. Measuring the emission of the pack at different distances with this calibrated chamber, we obtained the results given in Column 2 of Table VI. The values obtained with the calibrated lead chamber are given in the third column for comparison. The ratios between corresponding readings are shown in the last column. From these it will be seen that the two chambers, *when calibrated by gamma rays,* give essentially the same values for the intensity of radiation emitted by the pack. Since the two chambers differ widely in absorbing power, this close agreement indicates that the quality of gamma rays used for the calibration is essentially the same as the quality of the gamma radiation emitted by the pack.

The calibration factor for the graphite chamber obtained with hard X-rays of the type generally used in therapy, was found to be 1 division per minute = 1.47 r per minute. Applying this to the readings obtained for the pack, we find the gamma-ray emission to be 5.3 r per minute at a distance of 10 centimeters. It is important to note that this is 3.8 times larger than the value obtained with the same chamber when calibrated with gamma rays.

Such a large discrepancy could not be predicted and is difficult to account for. At the present time we can offer no satisfactory explanation, but the problem is being investigated further. Accordingly, the value given here for the gamma-ray emission of one gram of radium at one centimeter distance (36 r/min.) should be regarded as a preliminary estimate which is subject to modification later. A simpler way of investigating the problem is now available to us. The 900 K.V. X-ray tube recently developed by Dr. Coolidge has been installed at the Memorial Hospital. This produces radiation comparable in quality to the gamma rays of radium, but of much greater intensity than is possible to obtain with the present radium supply of the Hospital, and, therefore, our measurements will be facilitated considerably.

PART II (BIOLOGICAL)

1. *Selection of Material.*—In attempting to study quantitatively the biological action of radiation one is confronted with many practical difficulties. As a rule, living organisms which can be handled conveniently

in the laboratory are not very sensitive to radiation; therefore, in order to produce unmistakable changes, one is obliged to use very large doses of radiation, and, to do this in a period of time which is short in comparison to the life cycle of the material, it is necessary to have very powerful sources of radiation. This difficulty was overcome in our experiments by selecting two organisms which are rather sensitive, and by employing the most powerful sources of radiation available.

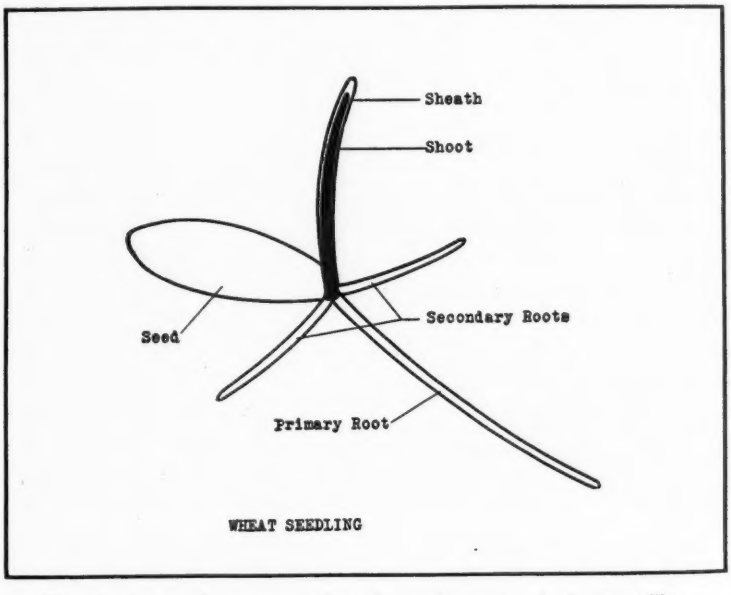


Fig. 21. Schematic representation of growing parts of wheat seedling.

Germinating seeds (19 to 27 and others) and *Drosophila* eggs (28 to 32) have been employed by various investigators to study radiation effects. Ware Cattell (33), working in this laboratory, studied the growth of wheat seedlings under different conditions and developed a technic which has given reliable results. This material possesses several distinct advantages, in addition to its being reasonably sensitive to radiation. The most important of these, from our point of view, lies in the fact that four growing tissues present in the seedlings may be studied under identical environmental conditions. Large numbers of seeds can be handled conveniently in the laboratory, thus making possible the use of statistical methods.

2. *Experimental Technic.*—The technic employed in our experiments was as follows. Wheat was obtained from the South Dakota Agricultural Experiment Station, the variety which we found to have the greatest fertility and to give the most consistent results being known as "Kota." A large number of seeds were first soaked for three hours in tap water, and from these only the most uniform in size and appearance were selected. These were placed in moist chambers consisting of large Petri dishes with moist filter paper at the bottom. They were allowed to develop in darkness in the moist chambers at 19.5° C. for 18.5 hours. At the end of this period the grow-

ing parts of the wheat embryo were bursting through the surface of the swollen seed, and those showing the greatest uniformity as to appearance, vitality, and degree of growth were selected for the experiments.

Fig. 22-*A (above)*. Cellophane moist chamber (open).
Fig. 22-*B (below)*. Cellophane moist chamber (closed).

During the first several days of growth of the plantlet five growing parts are present, as shown diagrammatically in Figure 21. Two of these, one within the other, grow upward to form the stalk of the wheat plant, while three grow downward to form the roots. The former consist of the *coleoptile,* or *leaf sheath,* which forms the first leaf above the cotyledon, and a mass of tissue within, which will later push through the coleoptile to form the second leaf. The latter will be spoken of as the *shoot.* Of the three parts growing downward, the one which appears first is the main root coming from the embryo, and this may be called the *primary root.* Following immediately are two lateral roots which are precisely alike in appearance and growth activity; accordingly they may be considered as identical tissues, and to these we shall refer as *secondary roots.* As previously stated, these growing parts are just breaking through the seed coat at the time that the material is utilized in the radiation experiment.

Two sources of radiation were employed in this experiment. One, the four-gram radium pack, has already been described in the first part of this paper. The other was a Coolidge X-ray tube with a tungsten water-cooled target so that it could be operated at 200 K.V. and 30 ma. if desired. The power was supplied to the tube by a high tension transformer equipped with a cross-arm switch for full wave rectification. Since the main purpose of the experiment was to compare effects produced by radiation when only the quality factor was varied, the output of radiation was adjusted to equal that of the pack at the respective distances used. This equality was first based on the ionizing power of the radiation and later on its biological effectiveness. It was decided at the outset, however, to use highly filtered X-rays, which could be considered to be

fairly homogeneous, and of high penetrating power, to minimize inequalities in the distribution of radiation within the biological material. These requirements were met by operating the X-ray tube at 165 K.V. and maintain the conditions under which it had been calibrated. A stabilizer in the tube circuit kept the current practically constant at 20 ma. throughout. The primary voltage of the transformer could be adjusted to the de-

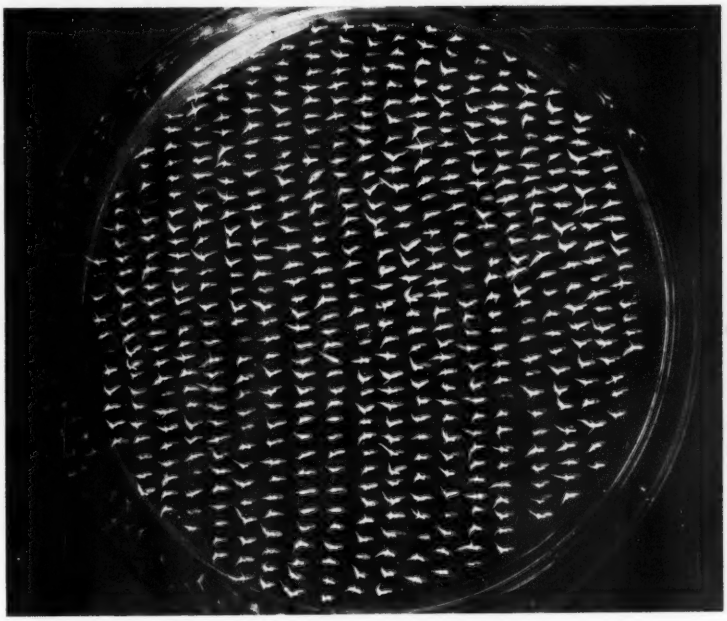


Fig. 23-*A*. Wheat seedlings 36 hours after germination.

20 ma., using a copper filter 2.04 mm. thick, and placing the material at a distance of 50 cm. from the target.

The intensity of radiation at this distance was measured by means of an ionization chamber which had been calibrated against our standard chamber under analogous conditions. Measurements were made "in air" and with "back scattering," as in the case of the radium pack (See Part I). The same water tank and the same thin-walled celluloid chamber were used. The irradiated field in the case of the X-rays was 12 $\times$ 12 cm., and the back scattering amounted to approximately 50 per cent of the intensity in air. During the irradiation period the X-ray machine was under constant observation to sired value by means of a slide wire rheostat. In most cases ionization measurements were made before and after the material was irradiated. The intensity was seldom found to be appreciably different.

In order to avoid complications due to secondary radiations the seeds were supported on very thin cellophane (0.025 mm.) while they were being irradiated. Two layers of cellophane were stretched over an ordinary embroidery hoop made of thin wood. On this was placed a piece of moist filter paper. The seedlings were then arranged in rows on the paper with the shoots pointing upward. A second embroidery hoop of smaller diameter with one sheet of cellophane stretched across was then

placed over the seeds, to reduce the normal evaporation of water. It should be remembered in this connection that the target of the X-ray tube was cooled by circulating water and therefore there was practically no heat emission from the tube. Accordingly the seeds were not exposed to heat while they were being irradiated with X-rays. In the experiments with gamma rays the cellophane cover was omitted, since the rim of the pack was brought down in contact with the cellophane tray and acted as the cover to retard evaporation. When the water tank was used the cellophane tray was supported in actual contact with the surface of the water by means of a strip of gauze stretched across the tank.

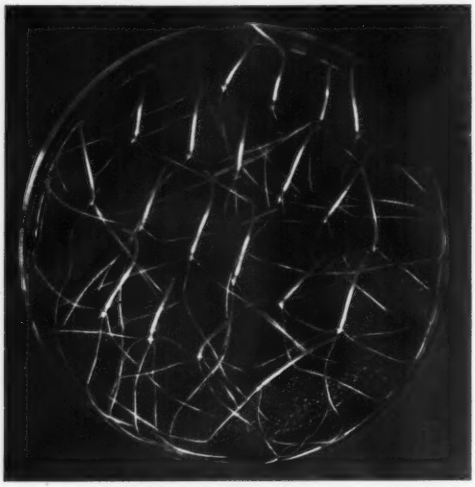


Fig. 23-*B*. Control seedlings at the time of measurement.

About eight hundred seedlings, selected as previously explained, were used for one experiment. They were divided at random into two equal parts for the radium and X-ray exposures, respectively. From each lot 60 seedlings were picked at random and were kept in small moist chambers as controls. The remainder were placed in two cellophane chambers, each containing about 340 seedlings. One of these and one control dish were taken to the X-ray machine, and the other lot, with its control, was carried to the radium pack room. The exposures were started immediately so that both sets of seedlings were irradiated simultaneously and at the same age. The controls during this period were kept, respectively, in the same room as these undergoing irradiation, to minimize the influence of possible differences in room temperature. In either case they were effectively shielded from radiation.

At the end of a predetermined time of exposure, 60 seedlings were picked from different parts of the cellophane tray and removed to two small moist chambers (30 in each) which were then placed near the control dish. The remaining seeds were again exposed to radiation to continue the treatment. At the end of the second period (usually equal to the first), another lot of 60 seedlings was removed from the cellophane tray as before. This process was continued until the last 60 seeds were given the maximum dose planned for the experiment. Following this, all the moist chambers were taken to the constant temperature chamber and were kept there at 19.5° centigrade.

Seventy hours later (*i.e.*, 94 hours after the seeds were first put to soaking in water), the four parts of the seedling, mentioned above, were measured for linear growth. At this age the shoot and sheath of the control seedlings are usually of the same length —about 30 to 40 mm.: the primary root is 57 to 80 mm. in length, and the secondary root is 33 to 50 millimeters. It will be noted that essentially the same percentage variation is present in the growth of the four tissues. It was found also that the same range of variation in length existed in the case of the irradiated seedlings. Since we are concerned here with ratios between the degree of growth of irradiated and con-

trol seedlings, this variation introduces no serious difficulties.

The seeds were removed from the moist chambers and the length of the growing tissues was measured along a millimeter rule, by one person, to minimize personal errors, the measurements being recorded on an adding machine by a second person. It was found that by recording the measurements for two tissues at a time this laborious procedure was facilitated considerably; nevertheless it required usually about four hours to carry out the measurements for one experiment. In this period of time an appreciable growth takes place, and for this reason the seeds which received the same dose of one type of radiation (as well as the controls) were kept in two separate moist chambers, as previously mentioned. There were then two sets of seedlings (30 in each chamber) for either type of radiation. The sequence of measurement for one set was from controls to those which had received the maximum dose and for the other set the measurements were made in the reverse order. Since the results of the two sets were then averaged, the growth which occurred during the time of measurement was thus taken into account.

In spite of the great care exercised in the experimental procedure, considerable irregularity was found among individual experiments. For this reason seven or eight separate experiments were performed under as nearly identical conditions as practicable. The results given here were derived from these experiments, and are shown as average curves. Points corresponding to single determinations are included in some of the charts in order to show the magnitude of the discrepancy just mentioned.

3. *Results Obtained with Wheat Seedlings.*—After preliminary tests were made with the X-rays in order to get the range of doses to be given the seedlings, the output of the X-ray machine was adjusted to the same value as that of the radium pack at 6 centimeters. Seedlings were then exposed to the two types of radiation for correspondingly equal periods; accordingly the doses expressed in roentgens were the same in both cases. It was found, however, that under these conditions the gamma rays were about three times as effective as X-rays. It was then decided to increase the output of the X-ray machine to about three times the initial value, in order that substantially equal biological effects might be produced in the seedlings, for the same length of exposure to X-rays and gamma rays.

The results for a number (7 for X-rays and 8 for gamma rays) of these experiments carried out under the same conditions (as nearly as possible) are all given in this paper. In Figure 24 only the effect on the shoots of the seedlings is shown, in order to simplify the discussion. In the upper part of the figure the results are plotted in terms of exposure time in minutes and percentage length of the shoots, taking the average length of the shoots of the controls as 100 per cent. Inspection of the two solid curves shows at a glance that, within the limits of experimental error to be expected in work of this sort, the *nature* of the effect produced by the two types of radiation is essentially the same. Or, strictly speaking, we should say that the variation of the effect with the magnitude of the dose, follows the same law in both cases (although equal doses do not produce the same effect). In other words, to produce a given increment of the effect in both cases the doses must be increased in the same proportion. From this it may be inferred that the primary action of radiation on the material under consideration is essentially the same for the two types.

It will be noted from the legend at the right of the upper curves that the ratio of the intensities of the X-ray and gamma-

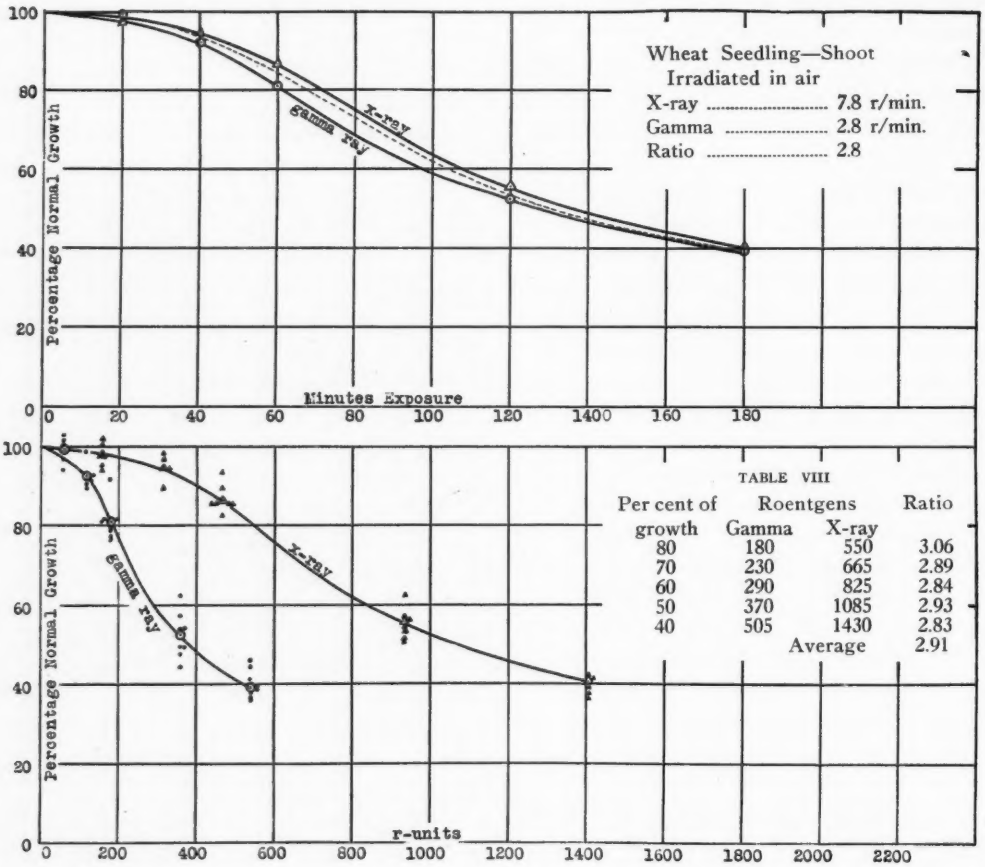


TABLE VIII

Per cent of growth	Roentgens Gamma	Roentgens X-ray	Ratio
80	180	550	3.06
70	230	665	2.89
60	290	825	2.84
50	370	1085	2.93
40	505	1430	2.83
		Average	2.91

Fig. 24. Curves showing effect of X-rays and gamma rays on the shoot of the wheat seedling.

ray beams used in this experiment is 2.8; therefore, the same effect was produced in the shoot by administering 2.8 times as much X-radiation as gamma radiation in the same length of time.

In the lower part of the chart the same two curves are plotted in terms of quantity of radiation expressed in roentgens. The individual experimental points are shown on this chart to indicate the degree of variation among the different experiments. It is important to note that no points and no experiments in this series have been omitted or discarded for any reason. The curves represent averages of all experiments. It is evident at a glance that there is a marked difference between the doses required to produce the same decrease in growth with X-rays and gamma rays. The quantitative relation between the two may be best obtained by taking the ratio of the doses required to produce the same degree of effect throughout the range. The values thus obtained are given in Table VIII, which is included in Figure 24.

It will be seen that for values of the percentage growth from 80 to 40 the ratios are essentially the same, with an average value

of 2.91. The constancy of this ratio, of course, is a consequence of the close agreement of the two curves in the upper part of the figure. Its magnitude (2.91) indicates that the intensity of the X-ray beam (7.8 r/min.) was not quite high enough in comparison to the intensity of the gamma-ray beam (2.8 r/min.) to produce equal effects in equal exposures. The X-ray intensity should have been $2.91 \times 2.8 = 8.15$ r/min. instead of 7.8 r/min. If a correction on this basis is made in the X-ray curve of the upper part of Figure 24, it comes closer to the gamma-ray curve, as indicated by the dotted line.

We may now consider the results obtained with the other tissues of the wheat seedlings. The average curves for all experiments are shown in Figure 25. As in the case of the shoots (which are also included in this chart), it is evident that the gamma rays were decidedly more effective in reducing the growth of the sheaths, primary and secondary roots. The sensitivity of the four tissues to either type of radiation is different as shown by the position of the curves in the chart, the sheaths being most resistant and the primary roots most sensitive, within a certain range. The crossing of the curves for primary and secondary roots was found in every experiment and therefore is not due to experimental errors. It is of considerable importance but its signifiance cannot be discussed in this paper.

An analysis of these results may best be made by considering the ratios of the doses required to produce the same degree of effect in each tissue. The ratios are given in Table IX. Those for the shoots (Column 3) are the same as already given in Table VIII.

The same constancy in the ratios for the shoots, already noted, is found in the ratios for the primary roots, but the average value is 3.5 instead of 2.91. We may again conclude, therefore, that the nature of the effect produced in this tissue by X-rays and gamma rays is essentially the same. The relative sensitivity of this tissue to the two types of radiation is, however, different from that of the shoot. More specifically, the roots of the seedlings, *while more sensitive than the shoots,* require *relatively* more X-radiation than gamma radiation to produce the same degree of effect, throughout the range investigated. The difference is

$$\frac{3.50}{2.91} = 1.20.$$

It is important to determine whether or not this is significant. In the ultimate analysis the question hinges on the relative positions of the curves for shoots and primary roots in the chart of Figure 25, for, the ratios being substantially constant throughout the range, it follows that the two average ratios cannot be made equal except by a proportional shift of all the points on one or more of the four curves involved. In order to attain equality of ratios by changing the position of only one curve, the shift must be about 20 per cent throughout. Since each curve represents the average of seven or eight experiments, it is hardly possible that a *constant percentage* error of this magnitude would be present. On the other hand, if equality of ratios is brought about by changing the positions of all four curves, the required shift in each is 5 per cent plus or minus, which is within the

TABLE IX

Per cent of growth	Ratio — X-ray / Gamma ray: Sheath	Shoot	Primary root	Secondary root
80	3.22	3.06	3.63	3.71
70	3.26	2.89	3.41	3.44
60		2.84	3.43	3.29
50		2.93	3.57	3.19
40		2.83	3.47	3.06
30				2.92
Average	3.24	2.91	3.50	3.27

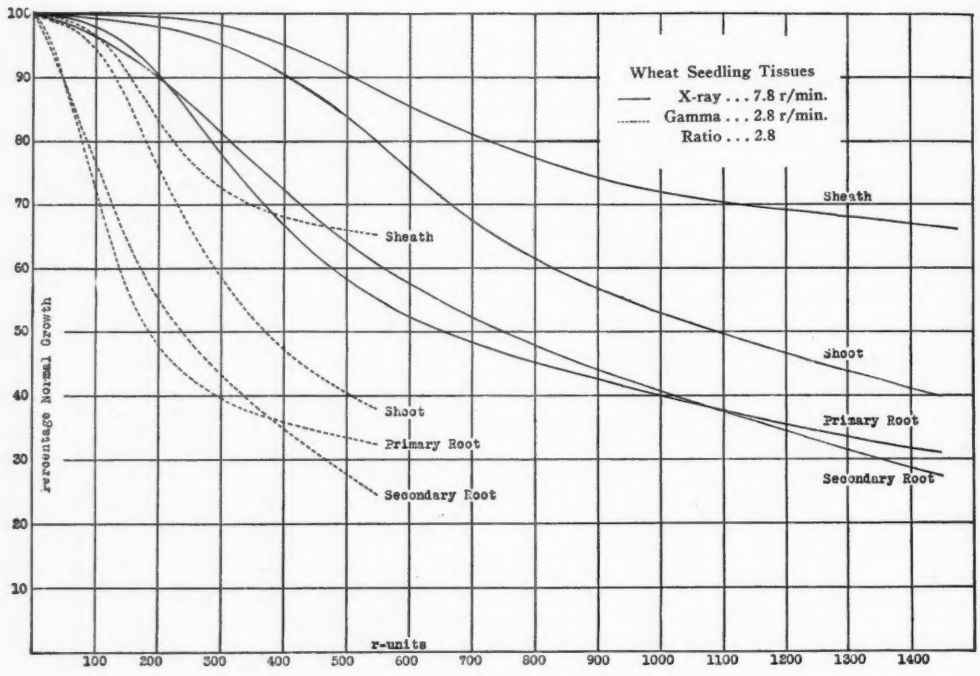


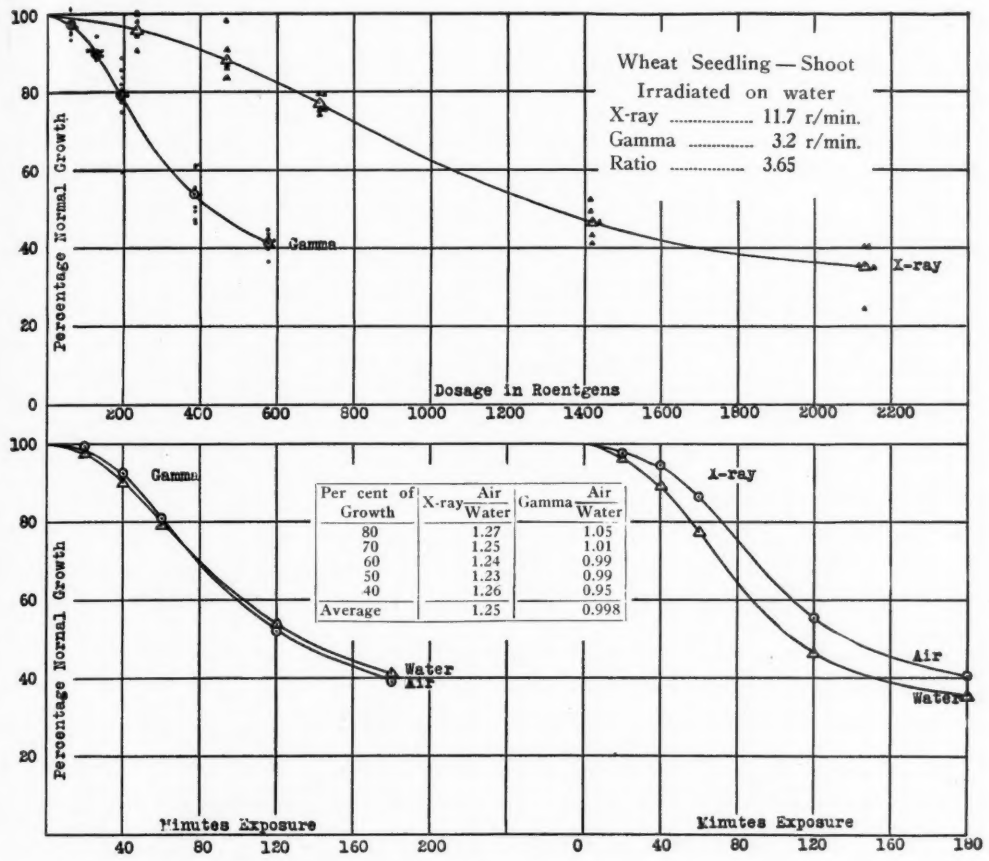
Fig. 25. Curves showing effect of X-rays and gamma rays on four growing parts of wheat seedling.

limits of experimental error. Hence on this basis we would conclude that the difference in the two average ratios is not significant, and that the existence of a differential effect of X-rays and gamma rays is not definitely established by the seedling experiments. There is, nevertheless, a reasonable indication of its existence.

The ratio for the secondary roots (last column of Table IX) is not very constant throughout the range. By inspection of the curves of Figure 25, it will be noted, however, that the most accurate ratios are those determined from points on the steep part of the curves, which fall between the 60 and 40 per cent growth levels. For these points the difference between irradiated seedlings and controls is large, and errors in linear measurements are relatively less important. Furthermore, the position of this portion of the curve is affected but little by appreciable differences in the experimental points, on account of the steep slope of the curve in that region. Considering, therefore, the secondary root ratios for the 60, 50, and 40 per cent growth points, the discrepancy is not large enough to be significant, on the basis of the information available at present.

The average ratio for this tissue falls between the ratios for shoot and primary root, the difference being too small to be attributed definitely to a differential effect. The same conclusion applies to the ratios for the sheaths, particularly since the two values given in the table refer to points on the upper part of the curves.

It will be seen later that X-rays and gamma rays are about equally effective in producing erythema on the human skin, whereas in the experiments just described gamma rays are distinctly more effective.



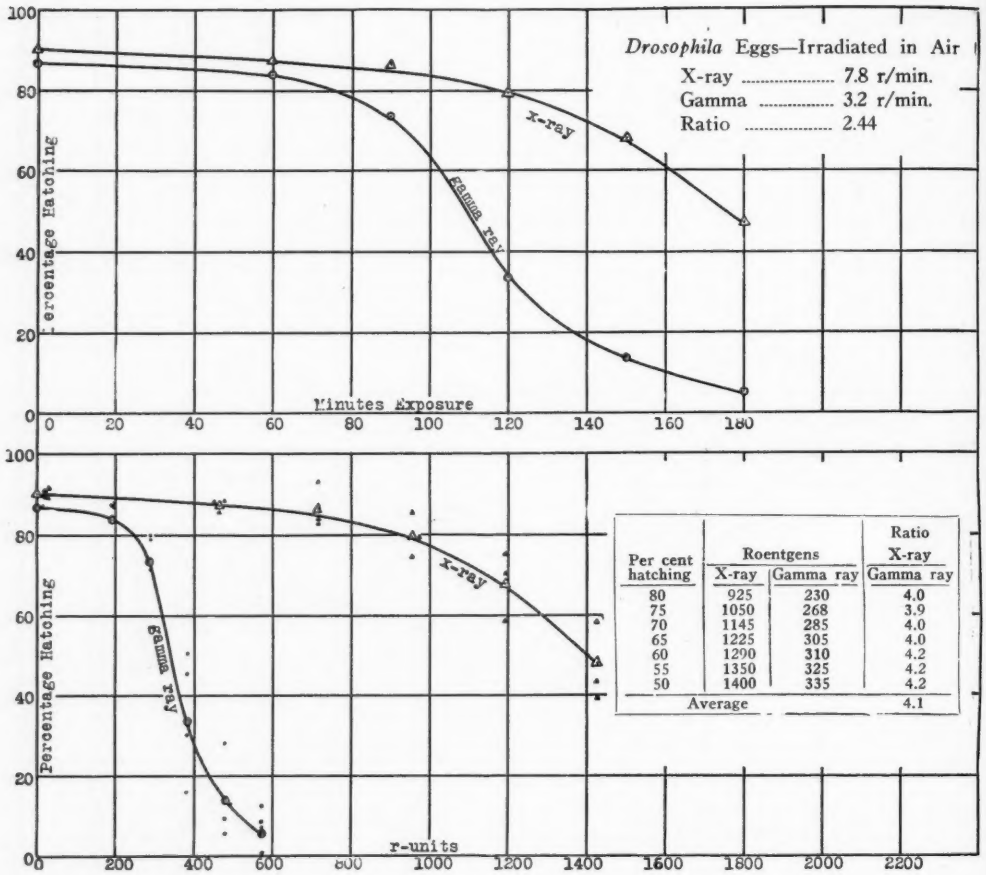
Per cent of Growth	X-ray Air/Water	Gamma Air/Water
80	1.27	1.05
70	1.25	1.01
60	1.24	0.99
50	1.23	0.99
40	1.26	0.95
Average	1.25	0.998

Fig. 26. Curves showing the effects of X-rays and gamma rays on the shoot, when irradiated over water to obtain the factor of "back scatter."

The comparison, however, is not quite justified on account of the fact that scattered radiation plays an important part in the erythema reaction, but was purposely reduced to a minimum in the case of these experiments. It seemed desirable, therefore, to investigate the effect of scattered radiation on the seedlings. A large water tank was used as the scattering medium and the seedlings were placed practically in contact with the surface of the water, by resting the cellophane tray on a gauze strip as previously described. The results obtained under these conditions, for the shoots, are given in Figure 26.

In this experiment the output of the X-ray machine was 7.8 r/min., as in the case where no scattering medium was used. Since the increase in scattering was found to be about 50 per cent by measurement with the thin celluloid chamber, we can estimate the intensity at the surface of the water to be 11.7 r/min. In the case of the radium pack we estimated (by extrapolation) the back scattering at 6 cm. to be 11 per cent. Hence the average intensity at the level of the seedlings[5] was 3.2 r/min.

[5]The seedlings projected into the rim of the pack about 2 mm.; therefore, the distance from the radium was 5.8 cm. and not 6 centimeters. Allowance for the shorter distance has been made in the values given.



Per cent hatching	Roentgens		Ratio X-ray
	X-ray	Gamma ray	Gamma ray
80	925	230	4.0
75	1050	268	3.9
70	1145	285	4.0
65	1225	305	4.0
60	1290	310	4.2
55	1350	325	4.2
50	1400	335	4.2
Average			4.1

Fig. 27. Curves showing the effects of X-rays and gamma rays on *Drosophila* eggs 3 to 5 hours old.

The curves in the upper part of the figure were plotted from these values.

The average ratio of gamma-ray and X-ray doses for equal effects was found to be 3.14. In view of the fact that the corresponding ratio in the case of the seedlings irradiated in air was found to be 2.91, we may conclude at once that the admixture of scattered radiation does not alter materially the relative effectiveness of X-rays and gamma rays.

It is of interest to note, however, that the increase in biological effect due to the presence of scattered radiation was not found to be in accord with our estimates; in fact, no increase is apparent in the case of gamma rays. The curves and table in the lower part of Figure 26 show this very well, the curves being plotted in terms of time of exposure. Accordingly, the fact that the two gamma-ray curves practically coincide indicates that the radiation scattered by the water contributed little, if at all, to the effect on the seedlings. In the case of X-rays the contribution amounted to about 25 per cent,

as will be seen from the table incorporated in Figure 26.

These results may be explained, at least in part, by the following considerations. The scattered radiation as measured by the celluloid chamber amounted to 11 per cent in the case of gamma rays. This radiation, being considerably softer than the primary radiation, is less effective biologically, for the same reason that X-rays are less effective than gamma rays, according to our experiments. Therefore, its contribution to the observed effect was less than 11 per cent by an unknown amount, which brings the difference within the experimental error.

In the case of X-rays the discrepancy between ionization measurements and biological effect is greater and more difficult to account for. In addition to the above-mentioned influence of the difference in quality between primary and scattered radiations, we may consider the question of position of the shoots with respect to the surface of the water. For this purpose we may include the corresponding results obtained with other growing parts of the seedlings. The ratio of time exposures to X-rays required to produce equal effects in the primary roots irradiated in air and on water was found to be 1.58; the corresponding ratio for the secondary roots was 1.32. We have, then, the following graded variation in these ratios: for shoots 1.25, for secondary roots 1.32, for primary roots 1.58, and for ionization in the celluloid chamber 1.50. If we consider the relative positions of the three tissues with respect to the surface of the water, we find that they are in the above order, the shoots being farthest and the primary roots closest to the water. (The ionization chamber was half submerged.) The difference in distance for the tissues, of course, is not large. Assuming, however, the presence of some very soft secondary radiation at the surface of the water, the difference in the position of the tissues may readily account for the observed results. The seed itself would emit secondary radiation, but it would nevertheless screen the shoot from a considerable part of the very soft radiation originating in the water.

TABLE X

	Ratio — $\frac{\text{X-ray dose}}{\text{Gamma-ray dose}}$			
	Shoot	Primary root	Eggs	Erythema
Without "scatter"	2.9	3.5	4.1	
With "scatter"	2.8	3.6	3.8	1.2

It would seem, therefore, that there is good agreement between the percentage of back scattering determined by ionization in a very light chamber half submerged in water, and that determined by a biological material placed very close to the surface of the water. This conclusion is confirmed by the results obtained with fly eggs, as will be seen later. Nevertheless the problem deserves further investigation.

On the basis of the experimental results we can calculate the effective intensities of the X-ray and gamma-ray beams at the surface of the water. From these, we obtain 2.84 as the average ratio of X-ray and gamma-ray doses required to produce the same degree of effect in the seedling shoots, a result which agrees very closely with the average value of 2.91 found in the case of seedlings irradiated in air. The corresponding ratio calculated on the basis of the intensities measured with the celluloid chamber was found to be 3.14, which differs from 2.91 by 8 per cent. Therefore, no matter how the ratios are obtained, it is evident that gamma rays are about three times as effective as hard X-rays in producing the

biological changes observed in the wheat seedling shoots.

4. *Results Obtained with Drosophila Eggs.*—The technic of collection of *Drosophila* eggs has been described by Packard (29), who has used this material very extensively in his work with radiation. Essentially the same procedure was followed by us.

Preliminary experiments showed that the sensitivity of the eggs to radiation varies markedly with age. Eggs three to five hours old are about five times more resistant than eggs one hour old, reckoning age from the end of a two-hour collection. This is true for both X-rays and gamma rays. It is important, therefore, to know the age of the eggs at the time they are irradiated, or at least to make sure that eggs within the same age range are used throughout. In our experiments it was decided to irradiate both seedlings and eggs simultaneously, in order to eliminate any possible variations in dosage between the two determinations, and for this purpose it was necessary to have a large supply of eggs available at a definite time (when the seedlings were of the proper age). For practical reasons this could be done best by collecting the eggs the day before they were to be irradiated.

Eggs were always collected from actively laying flies within a period of from two to three hours and were removed immediately to a refrigerator, and kept there at a constant temperature of 12° C. until the following morning. At this temperature development is brought almost, if not entirely, to a standstill. The manipulations necessary in the preparation of the eggs for irradiation necessitated exposure of the eggs to room temperature of 21 to 26° C. for a certain period—from three to four hours in each case. Eggs were spread evenly over small pieces of black filter paper about 1 cm. square, which were then placed in the central portion of the cellophane moist chambers containing wheat seedlings. It is evident that the age of the eggs used in the experiments is not known very definitely. However, the same technic was used throughout and there were no large differences in age even though we may not be able to assign a definite value to the equivalent average age. Indirectly this is shown by the close agreement of the results obtained at different times.

The experimental results are given in Figure 27. Since the eggs were placed in the center of the cellophane dishes, the intensity measured at this point in the gamma-ray beam (3.16 r/min.) has been used in the calculation of doses. The ratio of the intensities for X-rays and gamma rays is, therefore, 2.47. From the curves in the upper part of Figure 27 it is evident that, in spite of this difference in intensity in favor of X-rays, the gamma rays produced much more marked effects in equal exposures: the relative effectiveness of the two may be expressed again as a ratio of doses for the same degree of effect. The ratios obtained from the curves in the lower part of the figure are given in the table. As in the case of the wheat seedlings, the constancy of the ratio is also present here: the average value is 4.1.

In this connection it should be recalled that the conditions of irradiation for seedlings and eggs were identical, since they were exposed simultaneously. (The difference in the gamma-ray intensity noted above was due to the fact that the eggs occupied a small area at the center of the cellophane dish, whereas the seedlings were spread throughout the remaining portion of the field.) Nevertheless the dosage ratio in the case of the seedling shoots was found to be 2.9, and, in the case of the fly eggs, 4.1.[6] Since the difference between the two cannot be attributed to experimental errors, we

[6] If the average, instead of the maximum, intensity is taken as applying to the eggs as well as the seedlings, the ratio becomes 4.6.

may conclude that there is a differential effect due to the quality of radiation between seedling shoots and *Drosophila* eggs when irradiated under the conditions of our experiments.

Similar experiments carried out with the eggs on the surface of the water in a large tank gave the following results. The scattered radiation in the case of gamma rays had apparently no influence on the eggs, the ratio for equal exposure times with and without water being practically one. In the case of X-rays the scattered radiation amounted to 43 per cent as determined by its effect on the fly eggs. The ratio of X-ray to gamma-ray doses for equal effects, when back scattering was included, was found to be 3.8, which agrees with the corresponding value for eggs irradiated in air (4.1) to within 8 per cent and confirms the general conclusion previously reached.

5. *Comparison on the Basis of Skin Erythema.*—The fact that gamma rays, *when measured according to the method described in Part I,* are three to four times more effective, biologically, than X-rays, raises the question as to whether the conditions of measurement are comparable to those existing in the biological media employed. It has been pointed out already, however, that the ratio of effectiveness is not the same for all the tissues investigated. This suggests the existence of a *true differential effect with respect to quality which is independent of any method of measurement.*

Since both radium and X-rays have been used at the Memorial Hospital for many years in the treatment of patients, the amounts of these two types of radiation required to produce skin erythema are known with a fair degree of accuracy. Furthermore, numerous skin tests have been made by members of this laboratory during the last ten years to establish the "threshold erythema" doses under proper experimental conditions. Accordingly we are in a position to compare X-rays and gamma rays as to their relative effectiveness in producing erythema of the human skin.

Considering first the experimental data on threshold erythema (15, 16, 17, 18), we have: A tube of radon filtered by 2 mm. of brass and 2.4 mm. of pure gum rubber placed at a distance of 2 cm. from the skin, produces an erythema on the average patient with an exposure of 830 millicurie-hours. If the tube is considered as a point source, this corresponds to 450 roentgens. Applying a correction of 5 per cent for the length of the radon tube used at this distance, according to charts published from this laboratory (15), the threshold erythema dose under these conditions reduces to 430 r.

Threshold erythema doses for the pack are not known with the same degree of accuracy, because therapeutic doses are seldom administered at one sitting. A fair estimate for the 6 cm. distance is 10,500 mg.-hrs., and for the 10 cm. distance 22,000 mg.-hours.[7] Using these figures, we find that the erythema dose with the pack is 500 r, *including back scattering and taking the intensity at the center of the beam* as a basis of calculation. If the *average intensity* over the field is taken instead, the dose reduces to 480 r. It is difficult to decide which one of these two values really applies. Accordingly we may take for our present purposes *500 r* as the most probable value for the erythema dose when gamma rays are used. This, of course, is based on the measurement of gamma rays according to the method described here.

Similar uncertainties exist in regard to the erythema dose for X-rays. From our own experience and the values reported in the literature, we may say that 600 r delivered by hard X-rays (say, 200 K.V. and 0.5 mm. copper filter) will produce an erythema comparable with that produced by

[7] Values for radium packs applied at a distance of 6 cm. which have appeared in the literature range from 9,000 to 12,000 mg.-hours.

500 r of gamma radiation. The erythema in both these instances is probably more marked than our threshold erythema, for which the gamma-ray dose is known to be 425 r. For purposes of comparison, we shall use 500 r for gamma rays and 600 r for X-rays. This makes the ratio between the two 1.2 as against 3 to 4 found for the seedling and fly tissues studied experimentally.

It is important to note that the difference between these ratios is much greater than the uncertainty in the individual values used. Furthermore, this difference is independent of our method of measurement of gamma rays. Thus if we measure gamma rays by means of a small (graphite) chamber, as done by Glasser, the absolute values of the gamma-ray doses will all be about four times larger. The erythema dose for gamma rays will then be about 2,000 r, which is 3.3 times larger than the X-ray dose of 600 r. On the other hand, the doses which produce equal effects in *Drosophila* eggs will be about the same for both X-rays and gamma rays. Therefore, no matter how the radiation is measured, there is a distinct difference in the effectiveness of X-rays and gamma rays, for *some biological effects.*

6. *Discussion.*—The results derived from our biological experiments are summarized in Table X. They represent averages in two different respects: (1) At least several entirely separate experiments were carried out (both with and without "scatter") from which average curves were obtained; (2) then ratios were obtained from these curves for different degrees of effect and the average of these for each tissue was determined. By this treatment of the results biological variation and experimental errors are reduced to a minimum.

Each figure in the table represents the ratio of the X-ray dose to the gamma-ray dose required to produce the same degree of effect in a given biological material. Since all the ratios are greater than one, it is evident that in every case it takes more X-radiation than gamma radiation to produce the same degree of biological effect. But it is most important to note that the *greater relative effectiveness of gamma rays is not the same for all tissues investigated.* Thus gamma rays are 2.9 times as effective as X-rays in reducing the growth of the shoots of the wheat seedlings, but they are 4.1 times as effective in killing *Drosophila* eggs. In producing skin erythema this greater effectiveness is only 1.2 times that of X-rays. These differences are so large that they cannot be attributed to uncertainties in the individual values, considering the method by which they were obtained. We must conclude, therefore, that they establish the existence of the differential action of radiation (with respect to quality), which has been suspected but has never before been demonstrated experimentally.

This conclusion is independent of the method by which radiation is measured, since it is based only on the differences found among the dosage ratios for various tissues. The measurement of gamma rays by the method described in Part I influences only the *magnitude* of the individual ratios, *but not the relative values.*

Certain conclusions of some practical importance may be derived from these results:

(1) There can be no unit of radiation (physical or biological) which expresses its biological effectiveness irrespective of quality, over a wide enough range to include gamma rays. A "biological" unit is no better in this respect than one based on some physical effect produced by radiation of the type considered here.

This is evident from the following illustration, in which we shall purposely avoid any reference to a common physical unit of radiation for both X-rays and gamma rays. Suppose that we know the exposure time to produce an erythema, with a certain X-ray machine under definite conditions, to be one

hour. Irradiating *Drosophila* eggs of a certain age under these conditions we find that 50 per cent are killed by an exposure of two hours. We conclude from this that the erythema dose is one-half that required to kill 50 per cent of the eggs at this age. We then acquire four grams of radium for use in a "pack" and we wish to determine the erythema dose in milligram-hours for a certain setting of the appliance. Using *Drosophila* eggs of the same age as those irradiated with X-rays, we find that at a distance of six centimeters from the radium, 50 per cent are killed by an exposure of one and one-half hours. From the ratio obtained in the case of X-rays we conclude that an exposure of three-quarters of an hour given with the pack at 6 cm. should produce an erythema. The milligram-hour dose determined in this way would then be $4{,}000 \times \frac{3}{4} = 3{,}000$ mg.-hrs., which is about one-third of the correct value (10,500 mg.-hrs.). Therefore, on this basis patients would be undertreated (if one intended to administer an erythema dose). Reversing the procedure outlined above so as to "calibrate" by means of *Drosophila* eggs an X-ray machine from a knowledge of the erythema dose for the radium pack, would result in the administration of X-ray doses about three times larger than the erythema dose—with probable disastrous consequences.

(2) Having once found a difference in the biological effectiveness of gamma rays relative to that of X-rays, for some tissues, it follows that similar differences may be found for other tissues. In particular such differences may be present in the case of normal and pathological tissues of the human body. Accordingly the relative sensitiveness of these tissues must be determined for each quality of radiation employed. It may be found then that some tissues are relatively much more sensitive to gamma rays than to X-rays, and *vice versa*. This will provide a criterion for the selection of the type of radiation best suited for the treatment of any particular case. X-rays of a certain quality may be best in some instances and gamma rays in others.

(3) The greatest difference reported in this paper was found between the tissues used in the experiments and human skin. That is, gamma rays are three to four times more effective than X-rays in producing changes in wheat seedlings and *Drosophila* eggs, but they are only 1.2 times as effective in producing skin erythema. Since the experimental tissues were all embryonic, rapidly growing and rather sensitive to radiation, we may draw the provisional conclusion that these three properties of the tissues investigated were responsible, at least in part, for the observed results. These properties are also found in some human cancers. In such cases there should be a noticeable differential effect with respect to the quality of radiation.

Unequivocal experimental information bearing directly on this point is not available at present. There is, however, considerable subjective evidence based on clinical observations, which substantiates our conclusions. Radiologists who have used X-rays or large quantities of radium for the treatment of deep-seated tumors by external applications, are of the opinion that better results are obtained in *some cases* by radium than by X-ray treatments. For the proper interpretation of this observation one must consider the dose of radiation which can be delivered by the two methods. While gamma rays are much more penetrating than the hardest X-rays used so far, practical limitations of the quantity of radium available make it impossible to place the source at a great distance from the skin. Hence the advantage of greater penetrating power is more than offset by the operation of the inverse square law. In fact, it is found by actual measurements that hard X-rays deliver to a depth of 10 cm. in a water phantom, about 35 to 40 per cent of the radiation reaching the sur-

face of the water; while the corresponding depth dose for a radium pack at 10 cm. from the surface is about 23 per cent. Since the quantity of radiation reaching a tumor at this depth is considerably less in the case of the pack, the better (or even equally good) clinical results obtained by this method of treatment cannot be accounted for except by assuming that the gamma rays reaching the tumor are considerably more effective *on this tissue* than X-rays. Clinical observations, therefore, justify (at least provisionally) the application of our experimental findings to radiation therapy. We may conclude, therefore, that the *quality* of radiation to be used for the treatment of any particular case should be chosen with respect to its relative effectiveness between tumor and surrounding normal tissues (including the skin). Other conditions being equal, certain tumors should react better to gamma rays than to X-rays, and *vice versa*. This adds interest to the use of much higher voltages in X-ray therapy.

7. *Summary.—(a)* A direct method of measuring gamma rays in roentgens has been described. In principle, it is the same as the one ordinarily used for standardization measurements with X-rays. With the method and apparatus used by us the gamma-ray emission of one gram of radium was found to be 36 r/min. at a distance of one centimeter.

(b) Experiments have been described which make possible the direct comparison of biological effects produced by X-rays and gamma rays in five different tissues.

(c) The experimental results show that the quantity of radiation required to produce a certain degree of effect in a given tissue depends on the quality of the radiation.

(d) Therefore in radiation therapy the radiosensitivity of all tissues in the irradiated volume should be known *for each quality of radiation employed.*

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ELABORATION OF CRITERIA UPON WHICH THE EARLY DIAGNOSIS OF ACUTE INTESTINAL OBSTRUCTION MAY BE MADE, WITH SPECIAL CONSIDERATION OF THE VALUE OF X-RAY EVIDENCE[1]

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THE mortality in acute intestinal obstruction continues to be prohibitively high. Recent reports from large municipal hospitals where cases of bowel obstruction are frequently seen indicate that from 35 to 60 per cent of patients operated upon for acute bowel obstruction die (Miller). Despite the fact that marked improvement is manifest in the results of practically all other acute abdominal catastrophes, the mortality of obstruction to-day is almost that of forty years ago. This is due in large measure to late diagnosis, for any number of statistical studies indicate that when cases come to operation early the results compare fairly satisfactorily with the issue attending the surgery of other acute abdominal disorders.

Finney reports a mortality of 36 per cent in 217 cases, but within the first 12 hours the mortality was 5 per cent and for the 12-to-24-hour period, 11 per cent. Whereas the mortality in the entire group of 128 cases of acute intestinal obstruction reported by Tuttle was 41.3 per cent, in 13 cases operated upon within 6 hours there were no deaths and in the 25 patients operated upon within 12 hours the mortality was 4 per cent. In 124 cases reported by Brill the mortality for the group was 36.3 per cent, but of the 17 cases operated upon within the first 12 hours there were no deaths, and of 16 cases operated upon between 12 and 24 hours, 12.5 per cent died.

DIAGNOSTIC FEATURES OF OBSTRUCTION

The criteria upon which the diagnosis of intestinal obstruction is usually made are the following: Pain, nausea and vomiting, obstipation, meteorism, and collapse. All of these symptoms may be observed at some time during the course of obstruction, but usually at not sufficiently early an hour to afford the patient early remedial help.

DIFFICULTIES IN DIAGNOSIS

Absence of Local Physical Findings.—There are two factors, I believe, which are largely responsible for the difficulty in making the diagnosis. One of these is the absence of local physical findings in acute bowel obstruction. When obstruction of the strangulating variety is present, local physical findings are usually in evidence; when, however, only the continuity of the bowel is obstructed without vitiation of the blood supply of the intestine, early physical findings are absent. In all other acute abdominal disasters rigidity and tenderness occur early, suggestive of the presence of a serious lesion within. Were acute cases of appendicitis not heralded by the presence of tenderness or rigidity, undoubtedly a larger number would come to operation when peritonitis had already supervened. The very fact, however, that acute intestinal obstruction is the only serious abdominal disorder of an acute nature in which physical findings are absent early is of great importance. When a patient complains of intermittent, crampy, colicky pain, nausea and vomiting, but local physical signs are absent, the presence of bowel obstruction should immediately be accorded serious consideration. Patients with strangulated external hernias are, in every

[1]Presented before the Minnesota Radiological Society, Oct. 25, 1930.

series of bowel obstructions, the first to report for operation, indicative of the significance of local physical findings in the early diagnosis of all acute abdominal disasters.

Abuse of Enemas.—Next in importance in making an early diagnosis is appreciation of the fact that the patient with acute intestinal obstruction may evacuate gas and feces when an enema is administered. A large number of patients present themselves for surgery with late intestinal obstruction exhibiting meteorism, regurgitant vomiting, and collapse, and come only when all gas distal to the point of obstruction has been evacuated by repeated enemas. Just recently a patient came to my attention who was suspected of having intestinal obstruction but the diagnosis, despite obvious signs of obstruction, was not made because gas continued to be evacuated by enemas. Finally, the patient made his way to the operating table, but before the incision was made gas was spontaneously expelled and the surgeon had him returned to his room. A few hours later he died, and when an autopsy examination was made the nature of the obstruction was, of course, determined.

This criterion has been subjected to experimental scrutiny in the laboratory by severing the lower ileum of dogs and inverting both ends, and it was uniformly found that dogs expel enemas following complete obstruction of the intestine. It is well known that the bowel distal to the point of obstruction is anatomically normal (19). In other animals with an obstruction established in the same manner, but the distal end drawn out to the abdominal wall, it was found that the transit of barium through the distal loop was normal; on the X-ray film this loop usually appeared contracted. When a balloon was placed in the loop distal to the obstruction the peristaltic activity was observed to be similar to that of the normal intestine (3) (Fig. 1). The bowel distal to

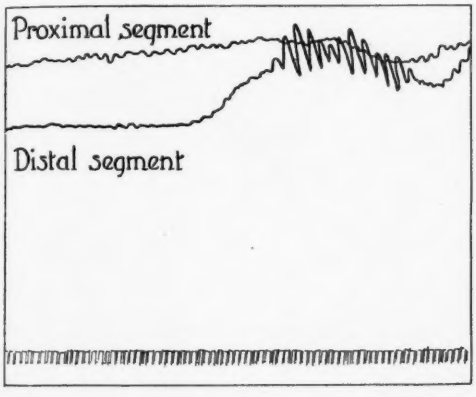

Fig. 1. Tracing made by placing a small rubber balloon in the obstructed segment and another in the intestinal loop distal to the site of obstruction. In this tracing the activity of the distal bowel is greater than in the proximal. The reaction to hypertonic intravenous saline and other stimulating agents is the same in the bowel distal to the obstruction as in the proximal.

Fig. 2. Gaseous distention of a short loop of small intestine on the left side of the abdomen in a patient with acute intestinal obstruction of 7 hours' duration. A loop of small intestine adherent to the anterior abdominal wall was found near this site.

the point of obstruction is, therefore, physiologically as well as anatomically normal. Why should not the patient with bowel obstruction expel gas? Only when the obstruction is low down and complete will no militate against the presence of bowel obstruction.

Distention is a late occurrence in acute intestinal obstruction, and regurgitant vomit-

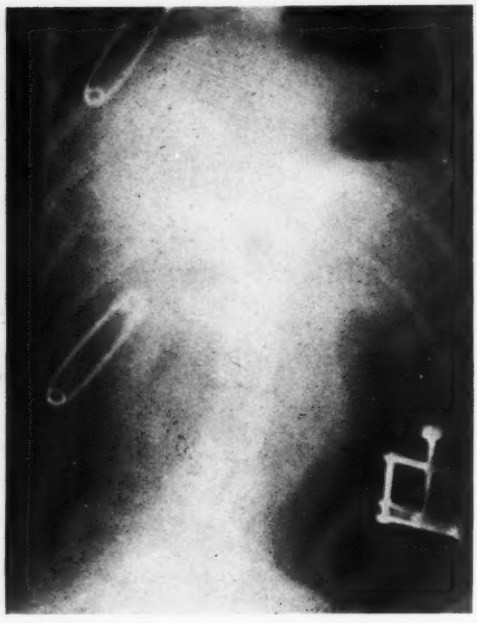

Fig. 3. Gaseous distention of small intestine in dog 4½ hours after the small intestine had been obstructed in the lower ileum.

Fig. 4. Gaseous distention in a case of peritonitis. The relatively thick intestinal walls between the dilated loops suggest the presence of exudate between them. The peritonitis had its origin in a suppurative appendicitis for which the patient was successfully operated upon.

gas be obtained when an enema is given, and undoubtedly on the first administration of an enema gas may be obtained.

It is, of course, a good plan to give enemas when a patient is suspected of having obstruction, and I like to observe the following plan in their administration. An enema, preferably a soap-suds enema, is first administered and a responsible attendant is present to evaluate the expulsion. Should the patient expel gas, and pain continue, another enema is administered after 20 or 30 minutes. If gas is expelled but pain continues, and the other signs point to an obstruction, operation is urgently indicated. The evacuation of gas and feces does not

ing, significant of the presence of a blocked bowel, is, of course, a late sign. The vomiting which occurs early in intestinal obstruction is of a reflex character, much as that observed in gallstone or kidney colic or in acute appendicitis.

Mistrust in Apparently Effectual Catharsis.—Occasionally one hears the oral administration of a vigorous laxative such as castor oil vaunted as an important aid in determining the necessity for operation in bowel obstruction. Just recently the unreliable information obtained through this practice in suspected obstruction came to my attention.

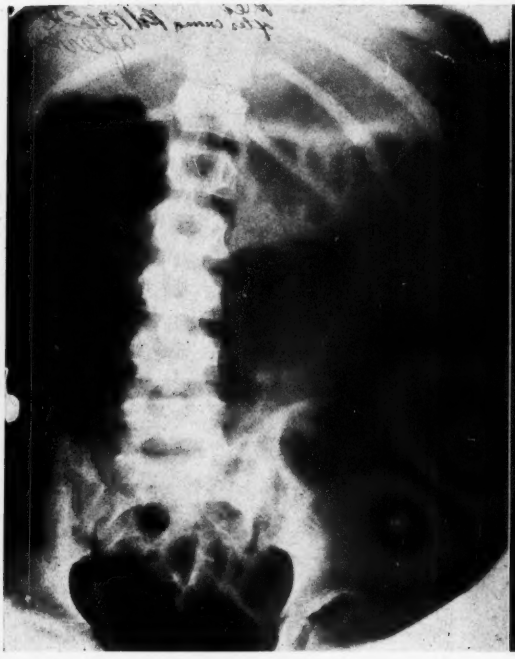

Fig. 5-*A*. Gaseous distention in a case of suspected intestinal obstruction. It is not clear whether the gaseous shadow on the left is dilated small intestine or whether it is colon.

Fig. 5-*B*. The same after the rectal administration of barium. The gaseous distention is distinctly seen to concern the small intestine.

A patient had convalesced nicely following the removal of an acutely inflamed appendix and an ovarian cyst encountered incidentally. About a week later she complained of unusually severe "gas pains," which were attended with vomiting. A mechanical adhesive type of obstruction was suspected, but when the ingestion of castor oil failed to aggravate the pain and was followed by the evacuation of small amounts of gas and feces, and enemas proved equally as efficacious, it was felt that no interruption to the continuity of the bowel existed. Only after several days, when distention gradually increased and the vomiting became regurgitant in character, was it appreciated that a partial obstruction was becoming impassable.

That it is decidedly unsafe to continue the expectant treatment in incomplete obstructions of an acute nature is a matter of common knowledge among surgeons of experience. Somewhat more than five years ago I had the humiliating experience of losing a patient through the belief that a partial obstruction was well tolerated. A mechanical obstruction developed in a young boy of 8 years, five days following an operation for diffuse peritonitis having its origin in a ruptured appendix. The boy, whose condition was desperate, was operated upon rather hurriedly and several adjacent loops of the ileum were found adherent to the anterior abdominal wall. These attachments were separated, but four intestinal fistulas developed in the loops adherent to the abdominal wall. Some months later, the segment of intestine concerned was excised and an intestinal anastomosis made. The immediate convalescence was without untoward event, but slight vomiting and intestinal distention

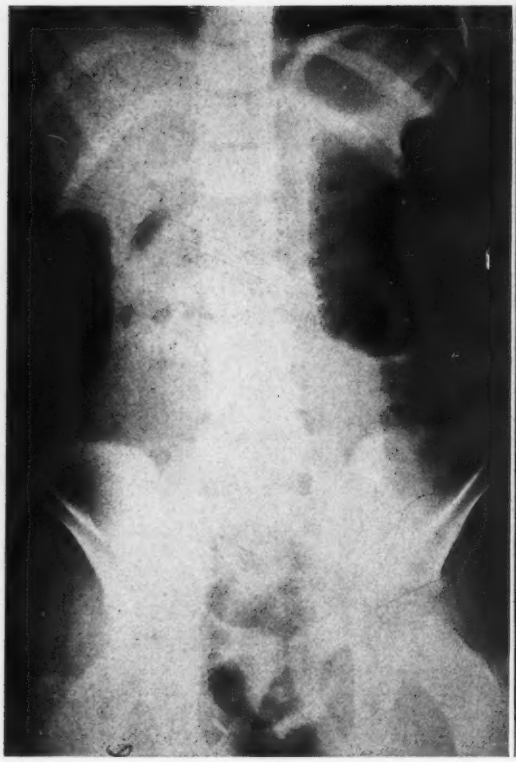

Fig. 6-*A*. Radiograph of abdomen of a child with a gangrenous loop 18 inches in length in the mid-abdomen. Gaseous shadows are visible in the left and right upper quadrants of the abdomen. No visible gas in the small intestine where the gangrenous bowel was found at operation.

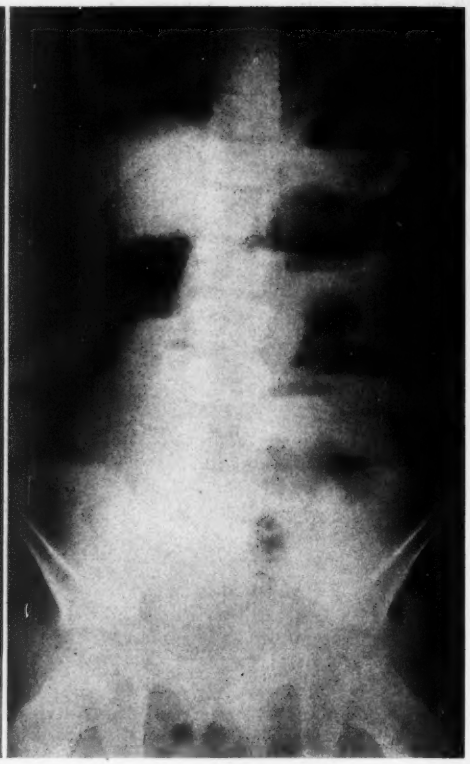

Fig. 6-*B*. The same, in the standing posture.

persisted. Unfortunately, too much emphasis was put upon the evacuation of a stool following the oral administration of castor oil and the appearance of ingested charcoal in the feces. The unfortunate lad died twelve days after the establishment of the continuity of his intestine from a partial obstruction. The night before, an explosive-like expulsion of gas and feces had been obtained following the administration of pituitary extract. A postmortem examination indicated that a secondary enterostomy would have replaced failure by success. To-day when operating for the closure of small intestinal fistulas, if the slightest doubt exists concerning the unobstructed continuity of the intestine below the fistula, I always perform an enterostomy above the intestinal anastomosis. It serves as an adequate safety vent, and, if clamped for a few days before removal of the catheter, reliable information is obtained concerning the continuity of the distal intestine. The administration of castor oil is not a satisfactory guide in the diagnosis of acute bowel obstruction nor is the expulsion of gas a reliable index as to whether or not operation is indicated. Persistence of pain indicates continuance of the obstruction.

Early in intestinal obstruction there is no change in the patient's general condition. The pulse is not quickened, and there is usually no disturbance of the body temper-

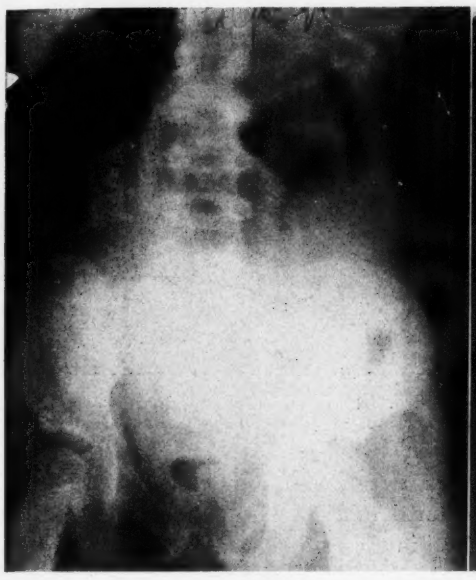

Fig. 7-*A*. Visible gas in small intestine and colon in a boy with suspected bowel obstruction.

Fig. 7-*B*. The same, three hours later, indicating the progression of distention of the small intestine and the necessity for immediate operation.

ature. The leukocyte count is not elevated except when vomiting has been present for some time, when a definite leukocytosis usually obtains. Alteration in the blood chemistry values, *viz.:* elevation of the blood urea, depletion of the chlorides, and an alkalosis, are, even in high obstructions, late signs of the disease and occur usually only after forty-eight hours. In low obstruction, they are frequently absent at any time. Altered values should therefore not be awaited before a diagnosis of intestinal obstruction is made.

Danger of Morphine.—A serious evil in the management of all acute abdominal disorders is the administration of morphine before the diagnosis has been made. Frequently both patient and physician are pleasantly lulled into a sense of temporary security by this disguise and the significant sentinel warning of intermittent colicky pain is silenced until physician and patient are apprized by the increasing distention, regurgitant overflow vomiting, and other sinister warnings that bowel obstruction is present, but, alas too often, too late to undo the harm wrought by the irremediable delay. Even following the administration of morphine, however, loud intestinal borborygmi may be heard over the abdomen significant of the abnormal peristaltic activity of the intestine (5).

The Stethoscope.—A much neglected criterion of physical examination in all cases of abdominal disorders of an acute nature is stethoscopic examination. When the abdomen is auscultated in the presence of a mechanical obstruction, loud intestinal noises coincident with the height of the pain are heard. These are frequently of an explosive character. Normally, intestinal noises may be heard in the abdomen. A metallic tinkle, when heard over the abdomen, indicates the presence of bowel that is dilated and already under tension. When sounds much like those occasioned by the dropping of water in a rain-barrel or caused by inverting a bottle and allowing the water to

Fig. 8-*A*. Distention of small intestine in a patient with pelvic inflammatory disease. At operation a mechanical obstruction to the continuity of the bowel was also seen. Gallstones are also visible on the film.

run out are heard over the abdomen in a patient complaining of colicky pain of an intermittent nature, it is very likely that an obstruction is present. Fluid and air are carried downward together by the peristaltic rushes in the intestine, and, as the obstruction is reached, fluid and air separate, giving rise to the gurgling noises. Intermittent, crampy pain not attended by local physical findings, but accompanied by loud, gurgling noises heard with a stethoscope over the abdomen, with maximum intensity at the height of the pain, is highly suggestive of acute obstruction of the intestine. The abdomen of peritonitis presents the "stillness of the grave." Visible peristalses, though pathognomonic of the presence of bowel obstruction, in the presence of a normal abdominal wall in my experience are rarely seen in acute obstruction, whereas, in obstructions of a sub-acute or chronic nature, they are practically always observed.

Fig. 8-*B*. The same, in the lateral posture, showing fluid mirrors.

On one occasion in a patient with a ruptured tubal pregnancy and considerable blood in the peritoneal cavity, exhibiting on an X-ray film gaseous distention of both large and small intestines, I have heard a few intestinal gurgles, but the absence of pain of an intermittent, crampy nature at the time that the intestinal noises were heard, as well as the local physical findings, served to eliminate the possibility of intestinal obstruction. In a few instances of peritonitis the abdomen is not absolutely silent.

In mechanical bowel obstruction occasionally, but much more frequently in the paralytic ileus of peritonitis, the heart and breath sounds may be transmitted over the abdomen. Fluid and gas in the bowel and fluid between the intestinal coils constitute a splendid medium for transmission of the sounds from the thoracic cavity.

X-RAY EVIDENCE

It has long been recognized that the X-ray is of value in detecting bowel obstruction, but this agent has not been accorded the importance it deserves in the diagnosis of acute intestinal obstruction. As long ago as 1911, Schwarz, of Vienna, described the presence of gaseous shadows in the small bowel, and indicated their significance in the diagnosis of acute bowel obstruction. He, however, was unwilling to commit himself to the diag-

nosis unless corroborative evidence was obtained by the administration of an opaque contrast medium. In 1914, Case described the significance of these gaseous shadows for the presence of bowel obstruction, and has since been insistent in emphasizing the value of this aid in diagnosis. Kloiber was the first, in 1919, to indicate that the diagnosis of bowel obstruction could be made on the presence of these gaseous shadows in the small intestine alone, and stated that the administration of barium was not necessary.

It is well known that when a plate is made of the abdomen of the adult, gaseous shadows are observed in the stomach and colon. Gas is also present throughout the small intestine, but the intimate admixture of gas and fluid in the small bowel precludes the distinguishing of gas from its immediate surroundings. The demonstration of gas in the small intestines on the X-ray film is, therefore, decidedly abnormal and is indicative of the presence of a mechanism interfering with the normal rapid rate of transit through the small intestines. The "ladder pattern," described by Case as a typical picture of bowel obstruction, need not be awaited to make the diagnosis (Fig. 2). Visible collections of gas in the small intestines of the adult are synonymous with intestinal stasis.[2]

In the experimental laboratory it has been found that definite X-ray evidence by the single plate method may be obtained within four or five hours after the establishment of simple obstruction in the small intestine (20) (Fig. 3). When the obstruction was established in the descending colon, the time of appearance of gaseous shadows in the small intestine was a variable factor, and was usually not observed earlier than from eight to ten hours. A few cases of malignancy in the pelvic colon causing acute obstruction have come to my attention in which no gaseous shadows were visible in the small intestine, despite enormous distention of the colon, and I have gained the impression that in a patient with acute bowel obstruction, suspected of having a malignancy in the colon, absence of gaseous distention of the small intestine strongly favors a carcinoma of the sigmoid, rather than a lesion in the right half of the colon.

Fig. 9. Radiograph of abdomen of a patient, aged 24, with considerable intestinal distention. She had been operated upon twice previously and presented all the findings of a mechanical obstruction. The distention is confined largely to the colon, however, suggestive of the presence of functional spastic ileus. A cecostomy was done because of the great distention and continued vomiting.

In taking the film, it is a good plan to make an exposure in the standing posture as well as with the patient prone or supine. In this position gas is visualized over fluid, giving the appearance of fluid mirrors. If the patient is too ill to stand, he may be turned on his side and fluid levels may as easily be demonstrated as when he is erect. A single plate taken with the patient prone or supine,

[2]Gas is regularly visualized in the abdomen of the infant up until past two years of age.

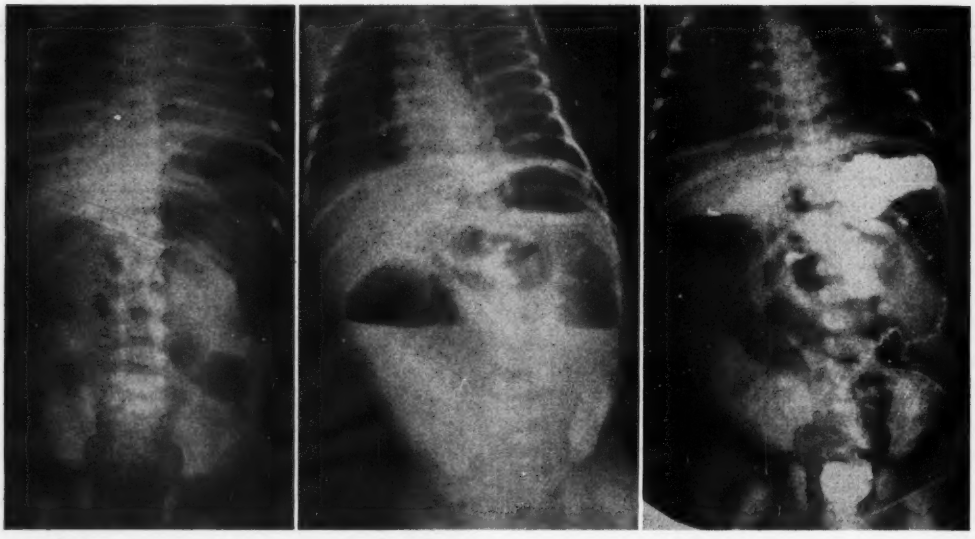

Fig. 10-*A*. Radiograph of newborn with intestinal atresia. The gaseous distention of the small intestine is apparent.

Fig. 10-*B*. The same, in the erect posture.

Fig. 10-*C*. After the oral administration of a little barium and barium by rectum.

however, gives all the necessary information, and the degree of intestinal distention is best determined from such a film. The oral administration of barium is to be deprecated in all cases of acute intestinal obstruction for the diagnosis can be made without it. Frequently, in instances of acute intestinal obstruction, when given it fails to leave the stomach and oftentimes takes considerable time before the barium goes down far enough in the small intestine to be of any value in locating the point of obstruction. It is far safer to locate and determine the nature of the obstruction at operation, at which time it can be done with much less risk to the patient.

The determination of whether the visualized gas is in the large or small bowel is occasionally a difficult matter. Gas in the small intestine is characterized by its central location; the long axis of the shadow is transverse, and when the loops are considerably dilated the two intestinal walls separating adjacent loops are seen as a very thin and narrow wall. The occurrence of a fairly thick wall separating greatly distended loops should suggest the presence of fluid or exudate between the loops (Fig. 4). Gas at the lateral borders of the abdomen is ordinarily in the colon; the long axis is usually vertical, and the intestinal walls are thicker and haustral markings are occasionally in evidence. On one occasion a small barium enema was given to differentiate whether the gas was in the colon or small intestine (Fig. 5). The administration of a little barium by mouth for the same purpose would appear to be justifiable, but as yet we have not found it necessary to have recourse to such a measure. The typical appearance of the gaseous shadows in the obstructed small intestine may be described as a stepladder arrangement of the coils; the mucous folds of Kerkring within the bowel lend a feathery appearance. However, it must be emphasized that this stepladder-like arrangement is not necessary to make the diagnosis. Visible gas in the small intestine of the adult is synonymous with intestinal stasis.

The stethoscope serves to distinguish the type of intestinal stasis. When mechanical in nature the occurrence of intermittent,

crampy, colicky pains, associated with loud intestinal borborygmi, establishes the obstruction as mechanical interference with the continuity of the intestine. If, however, gas is distributed throughout the colon as well, and the abdomen is silent on auscultation, it is almost a certainty that the obstruction is paralytic in character.

How many lives would be saved by the more frequent employment and judicious use of these two simple agents—the stethoscope and the X-ray! In many instances the diagnosis can be made over the telephone. The story of a previous operation, with the occurrence of intermittent colicky pain attended with nausea and vomiting, but no local tenderness or rigidity, are as suggestive of bowel obstruction as the "pain, food, relief" sequence in duodenal ulcer. The verdict of the X-ray and the auscultatory examination of the abdomen determine whether or not intestinal stasis is present, and whether it is mechanical or inhibitive (paralytic) in character.

In the trying situations that occur in the immediate convalescence after operation, when it is debated whether a paralytic ileus or an adhesive obstruction is present, these criteria are equally as dependable. Post-operative obstruction due to adhesions invariably concerns the small intestine. X-ray examination in its presence reveals gaseous shadows in the small intestine, with an empty colon. The stethoscope indicates the mechanical nature of the obstruction. Paralytic ileus would be heralded by a uniform distention of the colon and the small intestine on the X-ray film, and a death-like silence on stethoscopic examination of the abdomen.

There are, unfortunately, a few instances in which the differential diagnosis may be exceedingly difficult. Occasionally a paralytic type of obstruction fails to cause a general distention of the entire intestinal tract, causing, instead, dilatation of only a few coils of the small intestine. In the event that faint gurgling sounds can be elicited with the stethoscope, the diagnosis is especially difficult. The presence or absence of intermittent pain is significant. In inter-

Fig. 11. Radiograph of new-born with intestinal atresia at the point of juncture of first and second portions of the duodenum. The bile duct emptied into the distal segment of the duodenum and the meconium was green in colon. No gas in the small intestine.

rogating patients with suspected post-operative obstruction it is always essential to converse with them in their own language. I have several times been informed by such a patient that he has no pain, but when inquiry is made as to whether he has suffered from "gas pains," a voluble confession of such distress has been obtained. In borderline cases, evidence obtained from X-ray films spaced a few hours apart, as outlined below, is of great help (Fig. 7).

When strangulating types of obstruction were established in the laboratory, however, the gaseous shadows did not appear with such regularity as when simple obstructions were made (2, 8). In every strangulating obstruction a simple obstruction is also present above the strangulation; in order to obviate the confusion of this factor, seg-

Fig. 12-*A*. Gaseous distention of the abdomen in an infant with intestinal atresia.

Fig. 12-*B*. The same, with the infant held up by the legs in the inverted posture. The ease with which the bowel may be reached surgically is apparent.

mental obstructions were made by isolating a segment of the intestine and inverting the ends; the continuity of the remainder of the intestinal canal was re-established. Such an isolated segment, especially in the upper intestine, constitutes a true strangulation obstruction, for continued secretion in excess of absorption produces distention ulcers on the antemesenteric border of the intestine and finally rupture may occur. In such instances gaseous shadows were rarely observed early in the isolated loop. More recently, comparative studies have been made on the quantity of gas accumulating in the bowel in simple, closed loop, and strangulation obstructions (*Proc. Soc. Exper. Med.*, in press). It was found that gas accumulated in far greater amounts in the proximal bowel in simple obstruction to its continuity. Gas formation within a closed or strangulated loop was found to be an inconstant feature.

It has been a matter of general opinion that the strangulation obstruction presented a distended infarcted coil of bowel that could frequently be percussed out as a tympanitic mass as well as palpated through the abdomen walls. Wahl long ago called attention to this phenomenon occurring in volvulus of the sigmoid flexure and the sign has since been known as "Darmsteifung" (stiffening of the bowel). Undoubtedly, however, the mechanical interference with the continuity of the intestine rather than the deprivation of blood supply to the bowel (strangulation features) are responsible for this phenomenon. That the gaseous shadows in the small intestine in strangulating varieties of ob-

Fig. 13-*A*. Another infant with intestinal atresia held in the inverted posture. There is a lead disc over the perineal dimple. The rectum appears to be intrapelvic.

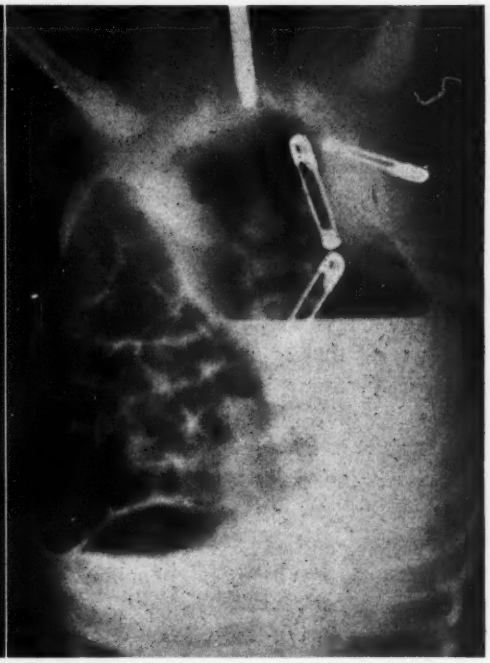

Fig. 13-*B*. The same, a few hours later, made in the same position. A slight pressure is being made over the anal dimple with a clinical thermometer. The *rationale* of approaching the lesion from below is indicated by the radiogram.

struction do not appear as early or as regularly as in simple obstruction merits emphasis.

The accompanying radiograph (Fig. 6), made from a boy of 8 years, with an intestinal obstruction of 80 hours, illustrates this in part. The visible gaseous shadows in the small intestine represent the distended proximal intestine. A gangrenous mass of small intestine about 18 inches in length occupied the central portion of the abdomen, where no gaseous shadow is visible on the film. Without exception, the instances of simple obstruction that have come to my attention, with an obstruction of as long standing as in this instance, have presented a continuity of "ladder patterns" in the small intestine when the exposure was made with the patient prone.

In simple obstruction visible gas accumulates early, directly above the point of obstruction. In strangulation obstructions, the bowel wall proximal to the infarcted coil is also somewhat hemorrhagic, and I have once come to grief in the resection of a strangulated bowel because of not excising sufficiently the hemorrhagic but viable bowel before making the anastomosis. In the instance of the boy referred to above, no primary anastomosis was made, but an exteriorization performed much as one does a Mikulicz operation for cancer of the sigmoid flexure. Only when the hazard of the obstruction had been survived was the continuity of the bowel re-established. As has been stated above, a simple obstruction is present immediately above every clinical strangulation obstruction, but why the gas fails to accumulate there or to become visible early on the X-ray film is not apparent. The altered state of the bowel proximal to the infarcted loop probably affords a partial ex-

planation. Fortunately, patients with this type of obstruction usually exhibit local physical findings and complain of intermittent colicky pain, at the height of which exaggerated activity of the proximal intestine may be elicited with the stethoscope. These findings suffice to make the diagnosis of bowel obstruction and indicate the necessity for immediate operation.

Attempts were made also to determine the reliability of the appearance of gaseous shadows in other types of intestinal stasis, *viz.:* interference with the portal or mesenteric veins and in peritonitis (*2*). Even though gaseous shadows in the small intestine were occasionally seen after ligation of the mesenteric or portal veins, visible gas in the small intestine did not regularly appear early. In peritonitis and in simple obstruction, gaseous shadows in the small intestine are an early occurrence.

The employment of the X-ray to determine the degree of intestinal distention has often proved of great value. In the instance of a boy admitted some weeks after appendectomy, because of occasional cramps and vomiting, it served to indicate the necessity for operation. This boy had complained of pain for about twenty-four hours, but had only one fairly severe pain after admission to the hospital. After being observed over a period of several hours, auscultation at the height of that crampy pain revealed the presence of loud intestinal noises. Three hours later, when another plate was made of the abdomen during which interval no pain had been complained of, and only occasional rumbles were heard with the stethoscope, it was observed that a marked progression in intestinal distention had obtained (Fig. 7). This served as adequate indication for immediate operation. When the abdomen was opened several coils of small intestine were found adherent in a loop-like arrangement, and they had formed a volvulus which in the course of a few hours would have progressed to a strangulation obstruction. A gas trap was formed, such that gas and fluid easily came in, but after a while neither escaped, due to the continued secretion of the incarcerated bowel which became more and more distended. The infrequency of the colics was undoubtedly due to the fact that the obstruction was only partial in character.

In a recent case of a patient with pelvic inflammatory disease, the X-ray evidence was of great aid in evaluating the findings and the history. The patient had complained of severe pain over the abdomen for some considerable period of time. There had also been a recent acute gall-bladder attack. When the patient presented herself at the University Hospital about three weeks after the onset of the distention, she complained of recurrent, intermittent, crampy abdominal pain, associated with vomiting. A mass was palpable in the pelvis and diffuse peritoneal irritation was present everywhere. The X-ray indicated the presence of gaseous distention of the small intestine (Fig. 8), and when the abdomen was auscultated at the height of the pain intestinal noises were heard, significant of the concomitant presence of bowel obstruction.

FUNCTIONAL SPASTIC ILEUS WITHOUT MECHANICAL OBSTRUCTION

There is a small group of cases that present all the symptoms of a mechanical obstruction of an acute nature but in which, at operation, no interference with the continuity of the bowel can be demonstrated. Seven such cases have come to my attention. They complain of intermittent crampy pain, exhibit nausea and vomiting, and usually considerable distention at the lateral borders of the abdomen but no tenderness or rigidity of the abdominal walls. At the height of the colics loud gurgling intestinal noises may be heard throughout the abdomen: small accumulations of gas may occasionally be made out in the small intestine, but the colon

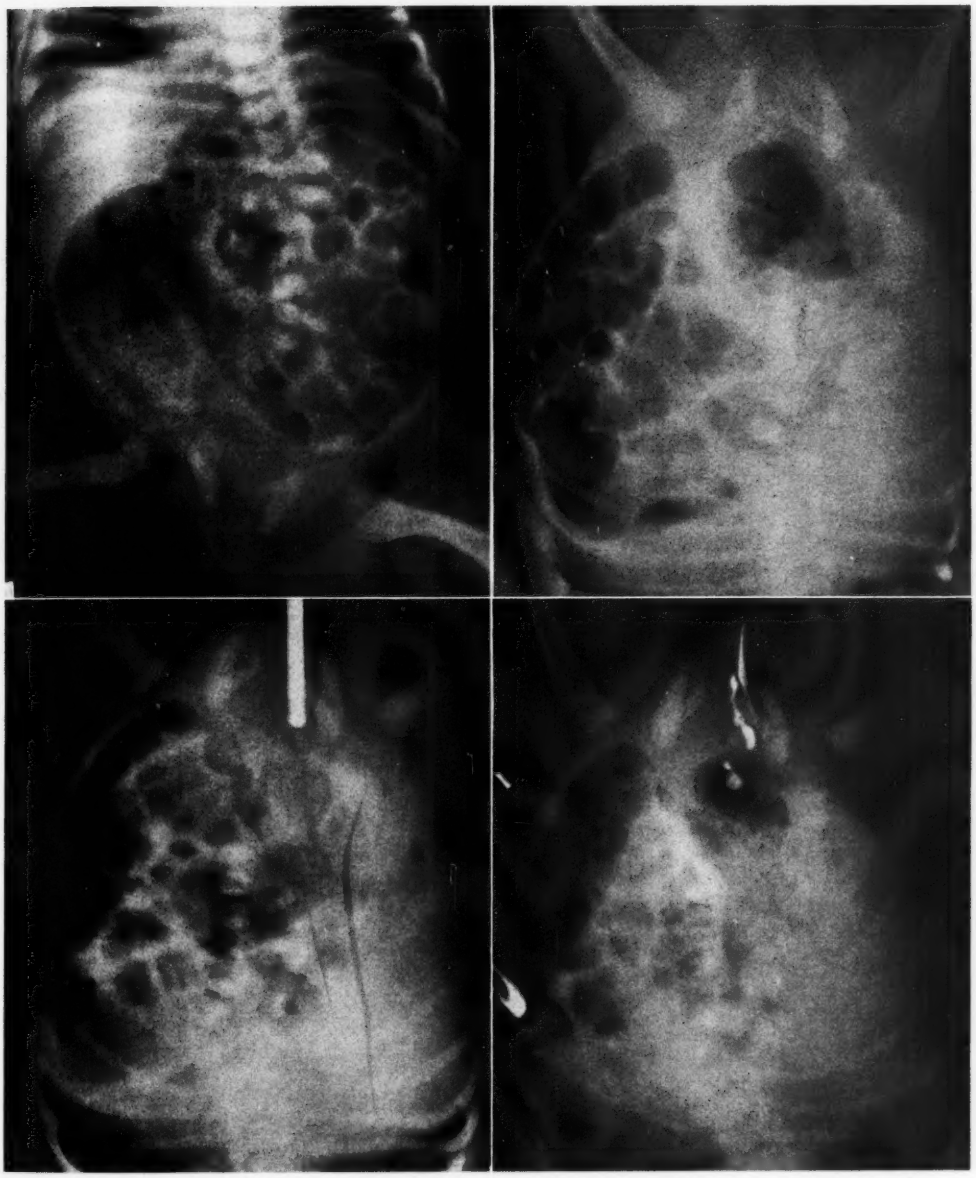

Fig. 14-*A (Upper left).* Infant with imperforate anus; plate taken with the child supine.

Fig. 14-*B (Upper right).* The same, in the inverted posture.

Fig. 14-*C (Lower left).* A clinical thermometer exerts slight pressure over the anal dimple. As this was done a slight amount of gas escaped and the rectal dilatation visible in 14-*B* disappeared.

Fig. 14-*D (Lower right).* After the injection of a few cubic centimeters of lipiodol, a fistulous tract communicated with the rectal ampulla; dilatation relieved the condition.

is invariably enormously distended, and considerable gas in usually observed in the stomach. On the administration of enemas, gas in small amounts is evacuated but without affording relief.

In what the essential disturbance consists

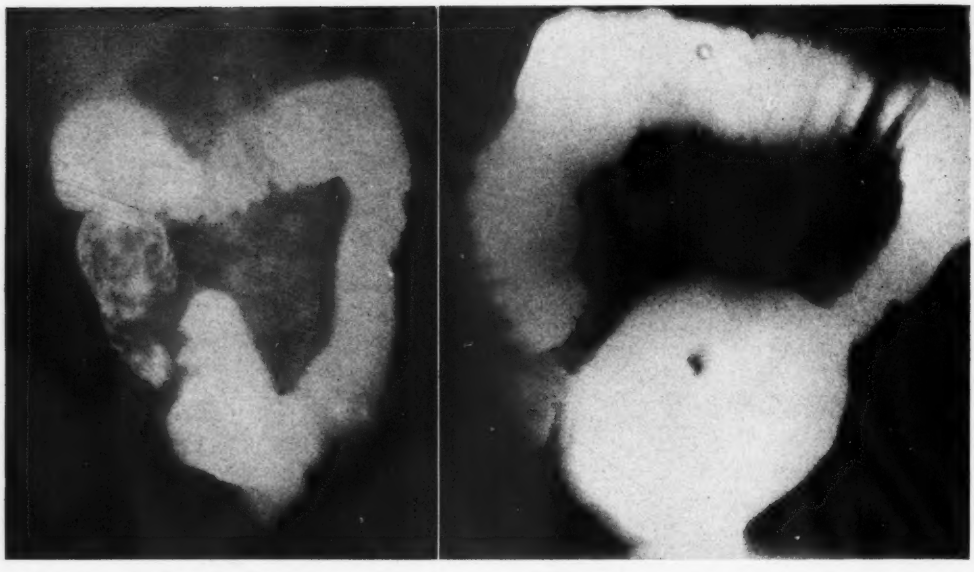

Fig. 15-*A*. Defect in the cecum in a male infant of 7 months, with a palpable tumor and blood in the stool (ileocecal intussusception).

Fig. 15-*B*. The same, after effective reduction with a barium enema under the fluoroscope.

is not apparent, but for want of more accurate knowledge concerning the obstructive phenomena in this condition the term "spastic ileus" may perhaps be well applied. Most of these patients have a functional bowel disturbance in which constipation is a prominent factor. I have looked upon the condition as one in which the small intestine is normally active and propels its content into a feebly acting colon that behaves like a large reservoir, the latter constituting a passive resistance or obstruction. That this postulate is not strictly true I have found by passing a balloon into the colon of such a patient and noting its normal reaction to drugs that stimulate the bowel wall.

In all particulars, however, these cases simulate a mechanical obstruction in the bowel. The roentgen findings, however, furnish an important clue by which the condition may be recognized, when the clinical and X-ray findings are jointly considered (Fig. 9). The marked distention of the entire colon, with colicky pain and loud borborygmi, speaks for a low obstruction. If a carcinoma of the pelvic colon can be reasonably excluded, a spastic ileus of the type described here is to be strongly considered. In case of doubt a barium enema would give unequivocal information as to whether or not an organic obstruction was present in the colon.

Fortunately these cases are rare. When the condition is identified, conservative measures may be given a reasonable trial before resort is had to operation. The first patients presenting this type of obstruction that came under my care were all operated upon. Latterly the gaseous distention of colon and stomach, with slight or no gas visible in the small intestine, has given me courage not to operate, despite the presence of intermittent pain and gurgling noises suggestive of a mechanical obstruction. A patient with six operative scars on her abdomen from previous laparotomies for obstruction, I have conservatively watched through two bouts of marked distention, fortified by

the confidence the X-ray affords in recognition of this syndrome. Despite the absence of organic obstruction, in the presence of an actively motile upper intestine a decompression (cecostomy) must occasionally be done and I have once felt constrained because of the enormous distention of the cecum to perform a cecostomy despite correct pre-operative recognition of the condition, in fear that the cecum might perforate. Recurrences of the trouble are not infrequent and I prefer to leave such a patient, if operation is necessary, with an appendicostomy to serve as a safety vent through which a catheter may be passed in the day of trouble.

Accompanying multiple fractures of the lower ribs as well as in a few acute adominal lesions as appendicitis, acute gall-bladder attacks, and renal colic, clinical distention occasionally occurs and it is observed that gas is visible in the small intestine. Here, however, the stethoscope serves as an adequate differential. In the gaseous distention accompanying these disorders the dilatation of the intestine is usually inhibitive in character and loud intestinal borborygmi at the height of the pain are absent. The occurrence of local physical findings serves also to identify the conditions just enumerated.

SPECIAL USES OF THE X-RAY

There are a few special conditions in which I should like to indicate the use that we have made of the X-ray in making the diagnosis of bowel obstruction. One of these is intestinal atresia. The obstruction is usually in the ileum, duodenum, or jejunum, and occasionally in the colon. In 15 per cent of such cases, however, the obstruction is multiple. In these instances it is usually a good plan to give some barium by mouth to make certain that the barium leaves the stomach. It has also been our plan to give a little barium by rectum, to be certain that the colon is not atresic. It has been my privilege to operate upon two such instances, but unfortunately neither patient recovered. On perusing the literature, however, I find that nine patients have made a satisfactory recovery following such an operation. In all instances an enteranastomosis was made. In no instance has an infant survived an enterostomy performed for the relief of intestinal atresia. The X-ray films of two such cases are reproduced here (Figs. 10 and 11).

In imperforate anus, the X-ray is an important agent in determining the degree of stenosis. Somewhat more than a year ago Rice and I had occasion to employ the X-ray in determining the degree of atresia in a patient who had an imperforate anus (Fig. 12). On holding the child upside down the gas ascends to the nearest point to which the bowel approaches the skin. It then becomes easily apparent how much of a surgical procedure is necessitated to establish communication with the skin. Not long afterward the opportunity was afforded to evaluate the worth of the method in another patient, in whom the X-ray indicated the difficulty but the feasibility of decompressing the atresic bowel from the perineum (Fig. 13). In a recent patient with imperforate anus the nature of the defect was disclosed and the type of procedure necessary for its relief indicated (Fig. 14).

There is another condition in which the X-rays are of value not only in determining the type of obstruction but also in therapy. I refer to intussusception. A few physicians have employed the single plate of the abdomen in the diagnosis of intussusception alone. Our experience, however, is that the diagnosis of intussusception can usually be made clinically by the presence of intermittent, crampy, colicky pains and the presence of a tumor. Intussusception usually concerns infants, especially of the male sex. It occurs between the fifth and ninth months of life in 50 per cent of the instances. The occurrence of intussusception in a child more than two years of age should arouse suspicion of the

likely presence of a tumor within the bowel or a Meckel's diverticulum. In the instances in which it has been my privilege to operate for intussusception in older children or adults, a polyp, carcinoma, or a Meckel's diverticulum has usually been found. Eliot and Corscaden found in 300 instances of intussusception in adults that in 100 cases tumor or a Meckel's diverticulum was responsible for the intussusception.

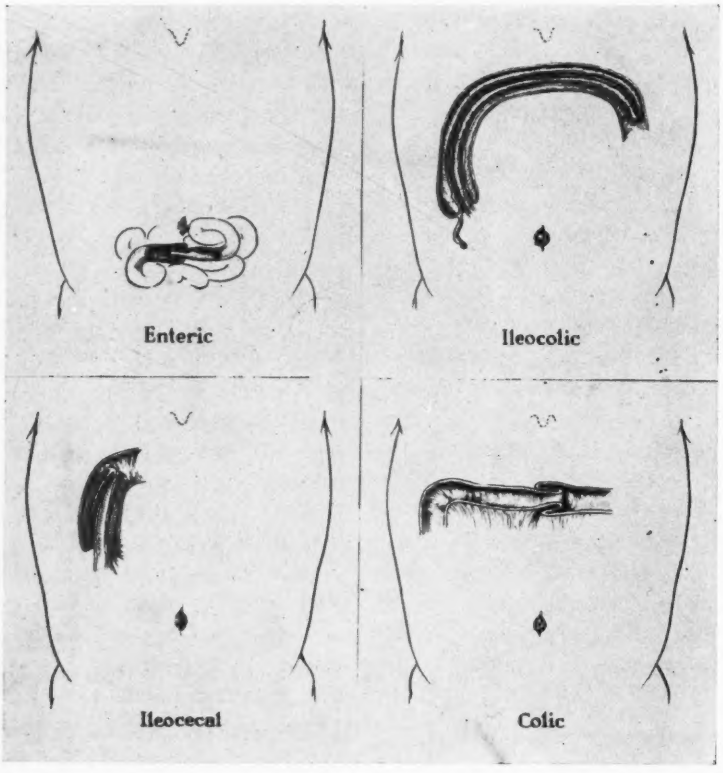

Fig. 16. Schematic drawings of the various types of intussusception. Reduction by means detailed here is likely of accomplishment in early invaginations of the ileocecal or colicocolic types.

A number of years ago Hirschsprung advised a non-operative method of reduction of intussusception and practised it with good results. His successor, Professor Monrad, at the Queen Louise Hospital in Copenhagen, reported recently 115 cases of intussusception, a large number of which he was able to reduce by the non-operative method. The best results to date that have come to my attention in the treatment of intussusception have been those reported by Hipsley, of Australia, in 1918. He reported 51 successful operative interventions for intussusception. In 1926 Hipsley wrote that he had become familiar with Hirschsprung's method and had used it in more than 100 cases with good results. He did not employ Hirschsprung's method of abdominal taxis under anesthesia, but allowed water to run into the colon under the influence of 3.5 feet gravity pressure. Hipsley stated that the results by the conservative method were so

good that he would be unwilling to submit a patient to operation for intussusception until the conservative means of reduction had been employed.

The Achilles' heel of the method as recommended by Hirschsprung is that there is no way of telling whether the intussusception has been adequately reduced until a spontaneous evacuation of feces occurs. Occasionally a considerable period of time intervenes until reliable evidence is obtained by this means, and in the event the intussusception has not been completely reduced, valuable time has been lost. Olsson and Pallin, from Key's clinic in Stockholm, a few years ago suggested the use of barium to determine whether or not the reduction had been effective. This is the manner in which we have used it. The accompanying illustration indicates its use (Fig. 15). A column of barium at a level of about three and a half or four feet should be used with gravity pressure only. The barium indicates the defect and at the same time affords a visual test of whether or not the reduction is complete.

The only invaginations that are likely of reduction by this method are the ileocecal and colicocolic. The ileocolic invagination is not easily reduced by this method, and it is, of course, of no value in enteric intussusception. A case of ileocolic intussusception in which the apex of the intussusception protruded at the anus has come under my observation in which the use of barium as described above pushed back the small intestine for a considerable distance, but operation was necessary to complete the reduction. About 70 per cent of invaginations in children are of the ileocecal variety in which the method should be effective if the child is seen early. In late cases in which an intimate adherence between invaginated and ensheathing layers has occurred, due to infarction of portions of the bowel, the method is not likely to be successful. When the method is ineffectual operation should be performed at once.

SUMMARY

The present high mortality in acute intestinal obstruction is due in large measure to late diagnosis. Revision of the usual criteria upon which the diagnosis of bowel obstruction is made is urgently indicated. Obstipation, regurgitant vomiting, and general abdominal distention portend the beginning of the end of life for the unfortunate sufferer with bowel obstruction. These must cease to be occurrences awaited before the diagnosis is made.

Intermittent, crampy, colicky pain associated with nausea and vomiting but unattended by local physical findings suggests acute intestinal obstruction. The bowel below the point of obstruction is physiologically as well as anatomically normal and will expel an administered enema, with the return of gas and feces. Gaseous shadows in the small intestine demonstrate the presence of intestinal stasis. The "ladder pattern" of gaseous distention in the small intestine need not be awaited to make the diagnosis. The stethoscope serves to distinguish whether the stasis is mechanical or paralytic in character. When the diagnosis is made early the mortality of operation for acute intestinal obstruction will exhibit a like improvement to that long ago manifest in the surgery of most other acute abdominal catastrophes.

In simple obstruction to the continuity of the small intestine gas may be visualized in the small intestine usually within four or five hours after the onset of symptoms. When the obstruction is in the colon a variable time may elapse before gaseous distention of the small intestine becomes visible on the X-ray film. In strangulation obstructions gaseous shadows in the small intestine do not appear as early as in simple obstructions and this criterion is, therefore, not as reliable an index as in the latter type

of bowel occlusion. In vascular occlusions of the mesenteric vessels, gaseous distention does not occur as early as in simple obstruction. In the inhibitive ileus of peritonitis, gaseous distention of the small intestine may be observed early. Gaseous distention of both colon and small intestine is almost invariably present. The presence of dense "bands" between the dilated intestinal loops suggests the presence of exudate between the intestinal coils.

The entity of functional spastic ileus which simulates mechanical obstruction in all clinical features may be identified by proper correlation of clinical and roentgen findings. The special uses of X-ray evidence of obstruction are enumerated for intestinal atresia, imperforate anus, and intussusception. In the latter condition the barium enema may frequently be employed to reduce the invagination.

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THE OSSEOUS CHANGES IN HYPERPARATHYROIDISM ASSOCIATED WITH PARATHYROID TUMOR: A ROENTGENOLOGIC STUDY[1]

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ERDHEIM first pointed out the significance of the parathyroid glands in relation to metabolism of calcium in the skeletal system. His observations of more or less marked increase in the parenchyma of the parathyroid glands in osteomalacia have since been confirmed by many observers, although his interpretation of this change as a form of compensatory hypertrophy has led to much discussion.

Verbitz, Langhans, and Kocher, in 1907, all reported association with a parathyroid tumor of multiple brown tumors of bone. Strada, in 1909, observed a woman, aged 54 years, with osteomalacia who had hyperplasia of the parathyroid glands. In three cases of senile osteomalacia, however, Strada observed that the parathyroid glands were normal. Bauer, in 1911, and Todyo, in 1912, found hyperplasia of the parathyroid glands in cases of osteomalacia and osteoporosis. Molineus, in 1913, found hyperplasia of the parathyroid glands accompanying three cases of osteomalacia with multiple brown tumors of the bone, multiple fractures, and infractions. In the same year, Paltauf and Askanazy reported a case of parathyroid tumor associated with osteitis fibrosa, multiple brown tumors of bone, and formation of cysts.

Schlagenhaufer, in 1915, observed a man, aged 43 years, with hypertrophy of the left parathyroid gland and marked osteitis fibrosa. Maresch, in 1916, reported the association of enlargement of the parathyroid glands with osteitis fibrosa cystica in one case, with osteomalacia in one case, and with multiple cystic lesions in several bones in one case. The parathyroid bodies were macroscopically hypertrophied in eight cases of senile osteomalacia and in twenty-eight cases of osteoporosis, but in five cases of osteitis deformans the changes in the parathyroid glands were less marked.

Fig. 1. Diffuse osteoporosis of hyperparathyroidism. The bones in general have a granular appearance, and those of the pelvis a striated appearance (Case 2).

Günther, in 1922, stated that almost all patients who have multiple brown tumors of the bones also have tumorous enlargement of the parathyroid glands. In the same year, Strauch reported the case of a woman aged 27 years who had marked puerperal osteomalacia, and a large parathyroid tumor. Danisch, in 1925, could demonstrate parathyroid tumors in only two of twenty cases

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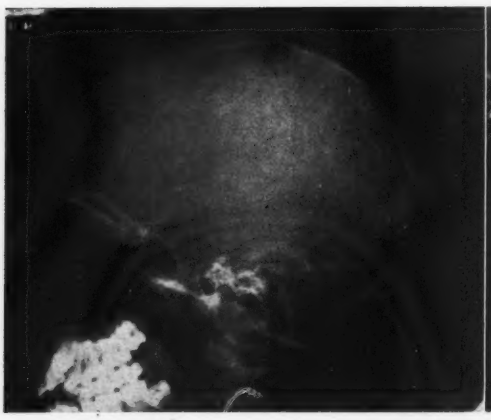

Fig. 2. Diffuse osteoporosis of the skull revealing the miliary granular appearance characteristic of hyperparathyroidism. There is apparent thickening of the frontal bone, and a fuzzy, indistinct outline of the outer table of the skull (Case 2).

Fig. 3. Miliary granular changes in the skull characteristic of hyperparathyroidism. The larger regions of decalcification simulate metastasis. There is thickening of the parietal bone and an indistinct outline of the outer table (Case 1).

Fig. 4. Early osteoporosis of the pelvic bones in hyperparathyroidism. This should be compared with Figure 5 (Case 1).

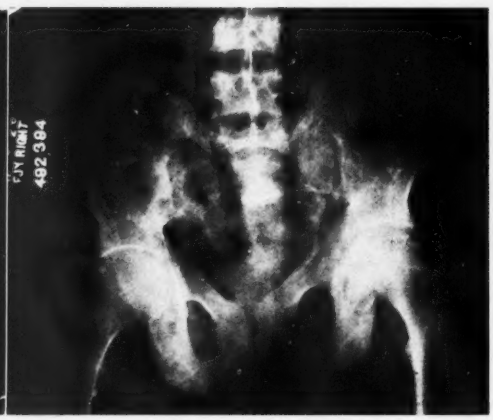

Fig. 5. Same case as that presented in Figure 4, three years and eleven months later, but before removal of the parathyroid tumor. There is marked osteoporosis, also cystic lesions in the right ilium and sacrum. The pelvis has become wedge-shaped, due to softening of bone and weight-bearing.

of senile osteoporosis. Hoffheinz, in 1925, reviewed forty-five cases of enlargement of the parathyroid glands, in twenty-five of which there were skeletal changes, and in seventeen of these, osteofibrosa was present. Mandl, in 1925, was the first to report roentgenologic data before and after operation in a case of parathyroid tumor. Before operation, osteoporosis and a fibrous appearance of the bones were present. Four months after operation, increased calcification was observed.

Richardson, Aub, and Bauer, in 1929, reported the case of a man, aged 34 years, in

which roentgenograms disclosed generalized osteoporosis, with rather coarse bone trabeculæ. Fractures had occurred and had healed normally. Two apparently normal changes. Snapper, in 1929, reported that improvement was demonstrable roentgenographically after removal of a parathyroid adenoma in a case in which there was gen-

Fig. 6. Cystic lesion in right femur associated with hyperparathyroidism. There is a resemblance to giant-cell tumor and the report after biopsy was "giant-cell tumor"; 6-*A*, anteroposterior view; 6-*B*, lateral view (Case 1).

parathyroid glands were removed, but roentgenographic examination two years later showed that the calcium content of the bones had markedly increased.

Barr, Bulger, and Dixon, in 1929, reported the case of a woman, aged 56 years, in which the roentgenograms revealed irregular areas of rarefaction in the bones, and cystic expansion of the maxilla. After removal of a parathyroid tumor, there was evidence of increased retention of calcium and the cystic tumor of the maxilla diminished in size. Boyd, Milgram, and Stearns observed a case in which the roentgenograms disclosed generalized osteoporosis, with cysts in almost all bones. The calvarium presented a moth-eaten appearance and the diploë were indistinguishable. There was alteration in the angles of the femoral and humeral heads. Two months after removal of a parathyroid adenoma, there was no demonstrable improvement in the osseous eralized osteoporosis with the formation of multiple bone cysts.

Compere, in 1930, reported that he could not demonstrate improvement as evidenced by roentgenograms five months after removal of a parathyroid adenoma; previously generalized osteoporosis had been found.

Our observations have been limited to two cases of hyperparathyroidism associated with tumor of the parathyroid glands. The clinical and surgical aspects of one of these cases, which will be called Case 1, have been reported in detail by Wilder, and the other case, which will be called Case 2, by Pemberton and Geddie. The roentgenograms of these cases have been reviewed in the light of our present knowledge of hyperparathyroidism, and we believe the roentgenographic changes are worthy of detailed consideration. A third case of hyperparathyroidism in which the osseous changes are even more marked than those of either of these cases

has not been included in this report because the presence of a parathyroid tumor has not as yet been confirmed by operation.

It is obvious, from a review of the literature, that the co-existence of changes in bone and disease of the parathyroid glands has long been noted. In brief, the predominating osseous changes described are generalized atrophy of bone and cystic lesions. No attempt seems to have been made to regard certain changes as characteristic of hyperparathyroidism, and nowhere in the standard English and German textbooks on roentgenology have we found the osseous changes accompanying hyperparathyroidism presented.

Fig. 7. Osteoporosis of hyperparathyroidism. There is an area of subperiosteal bone absorption and obliteration of the cortex on the mesial aspect of the tibia below the internal condyle (Case 2).

Fig. 8. Osteoporosis of hyperparathyroidism. There are areas of subperiosteal bone absorption and obliteration of the cortex at the lower end of the radius and ulna, and also on the lateral aspect of the neck of the radius (Case 2).

It is noteworthy that when roentgenograms are compared in cases of hyperparathyroidism, the fundamental and predominating changes in bone are similar. The fundamental change observed seems to be decalcification, and this is revealed chiefly as uniform miliary and granular mottling. This peculiar type of mottled atrophy is dis-

tinct from the ordinary type of change seen in osteoporosis associated with acute and chronic disease of bone, or in neurotrophic conditions. In our experience there is no other generalized lesion of bone which exactly simulates the miliary mottling and granular appearance of the bone in hyperparathyroidism (Fig. 1) and we believe such an appearance to be characteristic of this condition. The change is best exhibited in flat bones, and especially in the skull (Figs. 2 and 3). In addition, the bone trabeculæ become more delicate and indistinct, and the cortical bone is thinned. Because the bones are soft, bowing, kyphosis, narrowing of the pelvis (Figs. 4 and 5), and coxa vara may occur and produce noticeable diminution in stature. Deformities of the ribs may also occur and infractions of the long bones are not uncommon. In some regions the decalcification progresses to produce cyst-like lesions, and the jaw, pelvic bones, and femurs seem to be favorable sites for such changes. These lesions have been confounded with those of osteitis fibrosa and giant-cell tumor, and even biopsy of the cystic lesions frequently results in the diagnosis of giant-cell tumor (Figs. 6-*A* and 6-*B*). The presence of generalized osteoporosis, and the appearance of the miliary mottling in the skull should serve to distinguish hyperparathyroidism from osteofibrosa and from giant-cell tumor. In many instances the lesions are not accompanied by the expansion of the thin cortical bone that is seen in giant-cell tumor. In spite of the osteoporosis there appears to be some thickening of the bone in the frontal and parietal regions, although thickening has not been observed in other bones. Near the ends of the long bones, and in the phalanges, regions of subperiosteal absorption, with consequent obliteration of the cortex (Figs. 7 and 8) are seen.

The osseous changes have been confounded with those of metastatic carcinoma and multiple myeloma (Fig. 2), but the uniformity of the miliary mottling, and its presence in bones commonly not involved by either of these conditions, should serve to facilitate the diagnosis. The mottling observed in hyperparathyroidism is most closely imitated by the changes seen in metastatic neuroblastoma. In this disease, however, the associated periosteal reaction, and the perpendicular, ray-like formation observed best in the skull, pelvis, and long bones, should render the distinction easy. If doubt still exists, determinations of blood calcium and blood phosphorus will corroborate the diagnosis of hyperparathyroidism.

Fig. 9. Increase in density of calvarium and return of bone toward normal three and a half months after removal of parathyroid adenoma. This should be compared with the original film (Figure 1) taken three years previously. The miliary granular changes have disappeared but the small cystic lesions are still present and well demarcated.

In the literature, the term osteomalacia is used frequently in association with disturbances of the parathyroid glands. In the general sense of the word, osteomalacia is present, but roentgenographically the osseous changes in hyperparathyroidism bear little resemblance to those observed in the osteomalacia of pregnancy, hunger osteomalacia, and so-called late rickets. The pseudofractures and "unbauzonen" described

by Looser in osteomalacia have not been observed in hyperparathyroidism and will further serve to distinguish the two conditions.

Because of the disturbed calcium metabolism, renal calculi are not infrequently found, and were observed in Case 2.

Following the removal of a parathyroid tumor there appears to be a definite arrest in the process of decalcification, and the density of the bone, roentgenographically, is distinctly increased (Fig. 9). The bone trabeculæ, heretofore indistinct, become more dense and well delineated, and the margins of cystic portions are more sharply defined because of the increased calcium content (Fig. 10). The regions of subperiosteal absorption, observed in Case 2, decreased distinctly two months after removal of a parathyroid tumor, and were replaced by normal bone structure (Fig. 11). The cortex also gradually returned to normal thickness. Changes in stature, due to kyphosis, coxa vara, and softening of the pelvis, persist.

Fig. 10 *(Left)*. Cystic lesion in right femur three and a half months after removal of parathyroid tumor. This should be compared with Figure 6, of the same case, and the increase in density of bone and return of normal trabeculæ noted. The cortex is approaching normal thickness above the cystic lesion.

Fig. 11 *(Right)*. Appearance of tibia two and a half months after removal of parathyroid adenoma. There is increased density of bone, and the area of subperiosteal absorption seen in Figure 7, of the same case, has disappeared. The cortex of each femur has returned to almost normal thickness and the cancellous structure of the bone is now well seen.

SUMMARY

The roentgenographic changes observed in the osseous system in two cases of hyperparathyroidism associated with tumor of the parathyroid glands are presented. The osseous changes in roentgenograms consist of generalized osteoporosis, cystic lesions, and deformities. The generalized osteoporosis is characterized by a miliary or granular appearance. This change is best observed in the skull and appears to be peculiar to hyperparathyroidism. In addition, the bone trabeculæ and cortical bone are thinned, and areas of subperiosteal absorption are seen in the long bones and phalanges. Single or multiple cystic lesions are found in the jaw, pelvic bones, and long bones. These lesions are often confounded with those of osteitis fibrosa and with giant-cell tumor. The deformities due to softening of the bones con-

sist of kyphosis, narrowing of the pelvis, coxa vara, bowing of the legs, and infractions. It is not unlikely that pathologic fractures may even occur. In addition, renal calculi are not uncommonly found. In each instance, removal of a parathyroid tumor was followed by definite arrest of decalcification and progress toward restoration of normal bone structure, as observed roentgenographically.

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CHRONIC APPENDICITIS

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THE subject of "chronic appendicitis" seems to assume periodic importance in the medical literature. Just what each writer means by the term "chronic appendicitis" is often a puzzle. The meaning appears to vary a great deal according to whether the viewpoint is that of the pathologist or the clinician (1). In a previous article I defined "chronic appendicitis" from the clinician's viewpoint as "an appendix which is producing symptoms of distress to a greater or lesser degree over a considerable period of time. These symptoms may be local or remote from the source of irritation" (2). This does not limit us to the inflammatory type, but the appendix must be a source of irritation capable of giving local and remote signs and symptoms: the term "appendicopathia" would perhaps be more appropriate than "chronic appendicitis." One not infrequently reads and hears that "the X-ray offers very little toward the solution of problems of the appendix." On closer investigation one also finds out that these statements are generally made by those who are not in the habit of carrying the gastro-intestinal roentgen examination through the twenty-four and forty-eight hour periods or longer, or are not willing to consider anything but roentgen findings. "Chronic appendicitis," so-called, cannot always be diagnosed clinically or by the roentgen ray alone, but should be diagnosed by the careful weighing of all obtainable facts. If the roentgenologist provides himself with all available data in the interpretation of his roentgenological findings, he surely has by far the most valuable information obtainable. The roentgen findings properly interpreted are most essential, and the roentgenologist, with his gradually acquired knowledge of abdominal abnormalities, is the one who should weigh the evidence and make the interpretation. We cannot afford to omit a careful history, the symptoms, physical examination, and laboratory findings in conjunction with our roentgenological investigation. The roentgenologist should be a clinician and should not be too busy to give enough time to get these data, if they are not available from hospital and other records.

Our typical findings unfortunately are not always present; in fact, it may be stated that no two appendices, although pathologically identical, will present the same picture, yet atypical findings have value when interpreted in the light of clinical findings. It is our experience that the careful consideration of the clinical data often clarifies an apparent "hodge-podge" of roentgen findings. There is no question but that our most humiliating failures to interpret roentgen findings correctly in most cases could easily have been avoided by a careful consideration of clinical data. Unless we consider all clinical data we are also apt to ascribe too much importance to such abnormalities as we may discover but which may have very little in common with the chief complaint of our patient. Also, an appendix may show many of the earmarks of previous trouble, yet the damage may have been repaired and the appendix may no longer be causing symptoms.

Regarding the interpretation of roentgen appendix findings, the condemnation of this procedure is probably due to several reasons: in the first place, the examination is long and painstaking and requires several visits, which must be paid for; secondly, diagnoses have been made where evidence did not warrant the conclusions, and thirdly, an occasional report of our inability to determine the status of the appendix shakes the surgeon's confidence. The most typical findings may occasionally be erroneous, but no other diagnostic procedure is always ac-

curate, and an occasional failure should not condemn the whole. We attempt to prove that an appendix has all the evidences of normality and, also, none of the evidences of abnormality, or, *vice versa,* that it has all the evidences of abnormality and none of the evidences of normality, a double checking process. It has been my experience that a clinically suspected appendix is very much more often proven normal than abnormal. Fully 75 per cent of our population show, off and on, more or less tenderness on palpation of the right lower quadrant.

Every attempt should be made to ascertain the real cause of symptoms. The low percentage of cases showing permanent improvement after appendectomy for so-called "chronic appendicitis" would indicate that there must be something radically wrong with the diagnoses, and for this reason I am attempting a differential procedure, which, although not infallible, should materially reduce the errors. Much concerning appendicitis and related conditions could be written, but we shall attempt brevity.

The diagnosis of "chronic appendicitis" is in great part a diagnosis by elimination. We cannot limit ourselves to a consideration of the right lower quadrant. We may have local symptoms only or we may find our chief symptoms in the upper abdomen, or we may find a combination of both. The symptoms may be occurring at intervals only, they may follow indiscretions in diet, or they may be of a more or less constant nagging character. We will admit that the symptoms are not necessarily characteristic, but quite variable and often only suggestive, and may be quite similar to those found in numerous other conditions, which should be considered and eliminated if possible. We know our hyposthenic individual, especially when nervously tired, can develop a great number of abdominal symptoms. Numerous minor ailments with such patients seem to be responsible for most violent gastro-intestinal upsets when combined with injudicious eating.

In the differential diagnosis we must rule out such conditions as hernia or relaxed ring, kidney conditions, ureteral kinks or obstructions, nephrolithiasis, muscle strains, perinephritic infections, spinal arthritis and neuralgias, ovarian cysts and other tumors, pedunculated fibroids, malignancies, pelvic inflammatory disease, pregnancy (especially ectopic pregnancy), diverticulitis and diverticulosis, etc., and also numerous other conditions which indirectly produce right-sided symptoms, such as anal fissures, hemorrhoids, rectal stasis, colitis, etc. Tuberculous peritonitis and even tuberculous nodes are often the cause of abdominal symptoms. The presence of nodal calcification often indicates the probable presence of other swollen, tender nodes. Pulmonary conditions, like tuberculosis, even without intestinal involvement, often produce abdominal symptoms. We have all seen the results of too hasty appendectomies when the condition was an acute pneumonia, with pain referred to the right lower quadrant. Cardiac conditions often cause general and localized abdominal distress. Dental, sinus, ear, tonsil, intracranial and other conditions will affect the gastro-intestinal tract. The great majority of these conditions can be quickly ruled out in our differential diagnosis.

Epigastric distress, frequently associated with an irritative appendix, may be our chief complaint. From the symptomatic viewpoint we may occasionally get a history strongly suggesting gastric ulcer or gall-bladder disease, and in such cases every care should be exercised in not only ruling these out but in finding all the obtainable evidence of an irritated appendix. The sensation is generally that of epigastric distress rather than actual pain, burning, gnawing, or the like, or the patient may have a sense of epigastric pressure or a feeling of distention. Food may or may not have an immediate

effect on this sensation, but greasy and difficultly digested food often seems to precipitate these symptoms, which may last for days or weeks. Catharsis frequently gives relief for a while. Very often the patient complains of excessive flatus. Loss of appetite is frequent, and with this there may be nausea to a greater or lesser degree. Occasionally there is a dull ache in the lower right back. Flexing the thigh slightly on the abdomen often relieves a sense of "pulling" in the right lower quadrant. Short attacks of diarrhea, alternating with constipation, are frequent with many pathological appendices. Palpation may produce a sensation of discomfort when any part of the abdomen is so examined, and the colon is frequently spastic and tender. The pain in the right lower quadrant in a truly causative appendix will vary according to the local condition. This distress may not only be local but we find frequently even without real inflammation in the appendix that the entire gastro-intestinal tract is in an irritable state. So-called "duodenitis" is a term which has recently been much overused. We have undoubted cases of "duodenitis," but it is being diagnosed where further investigation would reveal an entirely different underlying or primary condition. Some of our proven irritative appendix cases show every evidence of duodenitis which may be attributed to the generally increased "irritability" of the entire gastro-intestinal tract. Slight indiscretions in diet, because of an already deranged gastro-intestinal function, frequently precipitate much abdominal distress, which is difficult to differentiate from true appendiceal "attacks."

So-called "chronic appendices" may show a great variety of pathological changes, many of a gross character, others made out only by the aid of the microscope. The latter should be liberally interpreted, as variations occur normally in different individuals and with advancing age. The grossly pathological appendices show a wide range of conditions. There may be enlargement, with edema; inflammatory exudates in the appendix substance or within the lumen, and denudation of the mucosa, or we may find merely vascular congestion, with or without some tissue edema. There may be nodular swellings separated by areas of sclerotic scars and denudation; general or partial obliteration of the lumen, or the distal end may be distended and even closed off from the remainder of the appendix and contain cellular débris or even sterile mucus. The appendix wall may be greatly thickened due to the inflammatory process or we may have a bulbous appendix, with marked thinning of the wall from pressure. There may be fecaliths of varying size and consistency.

Fecal concretions may cause local atrophy of the appendix wall, with local and remote symptoms. The evaluation of the degree of pathogenicity of an appendix fecalith is fraught with difficulties. A good proportion of appendices roentgenographically show fecaliths which probably, in the majority of cases, will not cause more than a rare twinge of local pain. These fecaliths may act as ball-valves and be the cause of acute local pains and also give all the symptoms of an acute gastric condition. The local pains which appear suddenly and disappear with equal suddenness we feel are often due to the accumulated gas and fecal matter attempting to get by such a ball-valve. It is impossible to anticipate what such a fecalith will do next. It should be carefully noted. Palpation of these fecaliths will often reproduce the symptoms complained of, which, if severe or of too frequent recurrence, even without other evidence of an irritated appendix, will justify surgery, which is often inevitable, as a truly pathological condition frequently develops. Between attacks of fecalith irritation or obstruction we may not be able to ascertain anything abnormal about the appendiceal condition, and if the appendix does not fill

we may not be able to note even the presence of fecaliths. Appendiceal kinks may act similarly. What appear to be kinks are often merely due to the angle of viewing. Large masses of pin worms in the appendix may also produce symptoms, local, and remote (reflex?). A slight fever is not incompatible with a non-inflammatory irritated appendix.

The question of appendiceal fixation is often a difficult one to determine. Inasmuch as a large proportion of inflammatory appendices result from obstruction of the lumen, we naturally find the distal end more frequently adherent than more proximal portions. In obese individuals palpation for the determination of appendiceal mobility is not always so satisfactory, but much can be learned by rotation of the patient through different angles and by observing the appendiceal position at different intervals. The position of the cecum varies considerably, according to the load it carries and the position of the patient. The position of the cecum will often necessarily affect the position of even an adherent appendix, but this rarely of itself causes much confusion. A long appendix gives more reliable information than a short one, as a short mesentery often might not allow much mobility of an otherwise normal free appendix. It may be stated here that a fixed appendix, by too deep and violent manipulation may be made to move *en masse* with other abdominal organs to which it may be adherent, and so seem to be mobile. A retrocecal appendix, the developmental production of which we shall not discuss, has been over-emphasized as a necessary reason for surgery. An appendix apparently retrocecal may be adherent to the anterior wall of the cecum and the differentiation may be most difficult. Viewing the organ laterally, its absolute fixation would seem to indicate a retrocecal appendix. That these retrocecal appendices more frequently produce symptoms than the ordinary variety does, however, seems to be a fact.

The question of fixation from the pathological viewpoint should be briefly considered. There are innumerable appendices which show evidences of a previous inflammatory process but which are not adherent. An inflamed appendix may show very little which is grossly abnormal on its serosal side: there may be a little injection of the blood vessels and the appearance may be a little less glistening. Such an appendix may function perfectly after the inflammatory process has subsided, but, generally speaking, fixation, kinking, ball-valve fecaliths, impacted inspissated feces, pin worms, appendiceal amebiosis, etc., all favor appendiceal stagnation and a continuance of at least a low-grade irritated condition in the appendix. The presence of abdominal adhesions, which are a frequent post-inflammatory appendix finding, is not always easily determined. A cecum may be malplaced or fixed by bands and developmental folds or by reason of redundancy, over-filling, etc. Pulling of the cecum or colonic wall definitely out of position frequently speaks for adhesions, especially when the bowel wall shows characteristic irregularities. The transverse colon may be drawn down and fixed, as may the duodenum and gall bladder. Dilation of small bowel loops might speak for obstruction from adhesions, etc.

The question of pain from adhesions has been given exaggerated importance—most post-appendectomy pains have been attributed to adhesions. We have seen cases without a symptom in which the abdominal organs were badly matted together by adhesions, and again, we have seen a single small band causing intense pain. The matter seems to be in great measure dependent upon the motility of the adhering organs and the area of surface attachment; in other words, a question of the tug on the sensitive peritoneum. The parietal peritoneum is much more sensitive than the vis-

ceral, but any tug on the mesentery gives rise to a sickening sensation and local pain. Palpating an adherent appendix may show tenderness from this peritoneal tug rather than from an actual inflammatory condition of the appendix. An appendix already under tension will be tender when the pressure is so applied that its distal end is put under increased tension, thus still further stretching the peritoneal covering. It is well to remember that a generally spastic colon has, through its more or less liquid and gaseous content, an equalized tension throughout, and this tension is, of course, transmitted to the appendix, which may be tender when pressure is applied as just described, while tenderness may be absent when the stroke of the palpating hand is toward the proximal end of the appendix.

Local pain on palpation must be carefully considered. This symptom may be most misleading, as we not infrequently see a badly inflamed appendix which is not tender to palpation, and caution in our interpretation is most essential. We may find a pain on palpating the cecal tip, the cause of which is not always easy to determine. The cecal tension may be fairly high, and this, with the increased palpatory pressure, may produce the pain. There may be a colitis involving the appendix. The cecum is often the site of an old fecalith which may produce local irritation. We occasionally see fecaliths here or elsewhere in the colon producing violent local inflammatory reactions. They may appear to become incorporated in the bowel wall by this inflammatory process. Tenderness about the cecum and appendix will often be found to be no greater than we find on palpating the remainder of the spastic colon. A colon, whose spasticity may be produced by an irritated appendix, is often inexplainably tender, which further complicates our differential interpretation of colonic and appendiceal tenderness. The subject of pain both on palpation and without palpation has been elaborately investigated (3). Carnett and Boles would have us believe that most right lower quadrant pain is of the nature of intercostal neuralgia, is quite superficial, and may extend over a wide area on both sides and even up the chest. Their method of determining the presence of tenderness upon tensing and relaxing the abdominal muscles, as a means of differentiating superficial from deep tenderness, is worthy of mention.

The relationship of superficial skin hypersensitiveness to deeper pathological conditions offers too great a variation of opinion to allow discussion here. I might add that quite a number of patients are so ticklish that they will tense and withdraw the body from the palpating hand under any circumstances, and so either give the impression of local tenderness or make the examination almost worthless.

Colonic spasticity, with its associated tenderness, has so many possible causes—many of remote, others of local, origin—that we shall not dwell on this subject. We feel, however, that colonic spasticity is frequently the result as well as the cause of appendiceal abnormalities, and should be observed but not over-emphasized. The various sphincteric valves of the colon (Busi, Hirsch, Cannon, Balli, and others) seem to be frequently more irritable and spastic than other portions of the colon. It would be well to mention here that in certain cases where there is a spastic constipation and general colonic tenderness, but no evidence of a truly irritative appendiceal condition, appendectomy has given relief from most of the abdominal symptoms for a variable period, generally from six months to two years. My personal explanation would be that the cutting of the appendiceal nerves (surgical trauma) raises our cecal gradient, which favors colonic elimination. When this elevated cecal gradient is gradually restored to a normal level we find our old symptoms returning, and perhaps with the

superimposed symptoms of operative adhesions. The surgeon should not judge his results until a liberal period of time has elapsed.

Appendiceal stagnation as determined by the retention of barium is a subject of considerable dispute. In the first place, barium retention cannot be proven when the cecum retains free barium, as the appendix may empty and refill, giving the impression of stagnation. As previously mentioned, appendiceal stasis cannot be considered as a probable cause for symptoms, although we do frequently find this association, especially when the appendix retains barium for a period of several days after the cecum has cleared. The ability of an appendix to empty would, however, indicate a free lumen in most cases, and would contra-indicate appendiceal surgery. With a closed-off bulbous tip we may find the proximal end filling and emptying with apparent normality, and if this sign were the only one observed, we should miss the true appendiceal condition. The detail of definition of the barium in the appendix has some significance. An appendix containing mucopurulent exudate may receive the barium, but it will show hazy, indistinct outlines.

The significance of an appendix which cannot be visualized should be considered. This condition is present in about 25 per cent of our cases and offers our most difficult situation. An appendix containing barium but lying over or behind a cecum filled with barium may be easily missed and may show up only after the cecum is clear of barium. It is also possible for an appendix to fill and empty between examinations. It often varies in its ability to take up barium. At one examination the appendix may be plainly seen, while, a few days later, it cannot be visualized. It is most important to make a second examination, after catharsis (the twenty-four-hour examination is usually the most successful for this), before we begin speaking of a blocked appendix. A swollen non-visualized appendix may sometimes be palpable and the pain may radiate to the opposite side or to the para-umbilical region. Local tenderness should be most liberally interpreted in these cases.

The roentgen study of so-called "subacute" appendices offers us considerable aid in the interpretation of roentgen findings in the less acute or chronic forms. The chronic forms we have already described; the sub-acute variety includes appendices in which the reaction is not so violent or in which the acute process has subsided considerably. If inflammatory products have access to a patent appendix lumen, the free drainage will tend to relieve symptoms. A few of the more common roentgen findings are worthy of note.

Needless to say, one finds much variation from the normal. Our stomach may show much irregular hypermotility or we may find gastric atony. There may be duodenal stasis and much erratic reverse small bowel peristalsis. Findings more characteristic, but not invariably present, are pylorospasm with a tendency to a six-hour stomach residue (this seems to be more often present when there are symptoms of nausea). The head of the barium meal may not pass the ileocecal valve at six hours and we find that, having passed this valve, the meal tends to hurry beyond, very much as we find in intestinal tuberculosis. The meal hesitates in its advance toward the ileocecal valve and then rushes beyond, apparently avoiding the zone of appendiceal irritation. The colon is frequently very spastic throughout, and shows frequent variations in appearance. These same events occur to a greater or lesser degree in all forms of chronic appendix irritation. One rarely finds any evidence of a proximal colon retention at the forty-eight-hour period, although small amounts of barium may often be seen in the cecum. The irritable contraction of the valve of Busi may be a reason for this slight retention of barium. The extreme

spasticity of the colon may actually retard bowel evacuations. One practically never sees an atonic cecum and proximal colon with large amounts of barium at this period when the appendix is in an irritated condition. Very rarely, we find cecal contents so indurated from many years of local stagnation that even cathartics will not expel them. Such fecaliths may absorb barium and give the appearance of proximal colon stasis and inactivity. If the cecum and proximal colon clear within forty-eight hours, we have eliminated one of our most frequent causes of right lower quadrant distress, namely, cecal stasis with its associated symptoms. Cecal stasis must of necessity often be the cause of appendiceal stasis, the precursor of many of our pathological appendices.

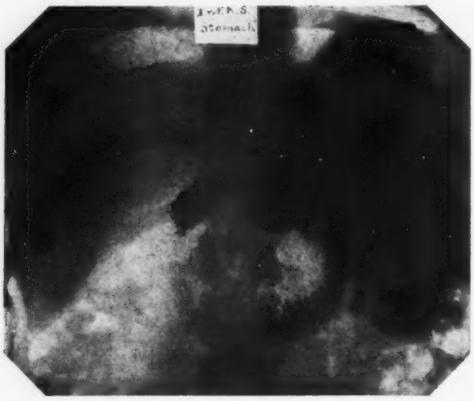

Fig. 1. "The stomach presents several points of interest." See text.

We have described the more important clinical and roentgenologic findings in appendiceal disease, in a rather disconnected manner. However, each point considered can be evaluated only in its relationship to all other findings in any given case.

CONCLUSIONS

Roentgen findings of appendiceal disease are most valuable but must be considered only in the light of all other clinical data. The evidence to be considered is local and remote and dependent upon the kind and degree of appendiceal abnormality. There can be no set of rules to govern the diagnosis of a pathologic appendix, and personal judgment must necessarily enter. The roentgenologist, in view of his long experience with numerous roentgen abnormalities, is in a most favored position to interpret these roentgen findings, providing he avails himself of all other obtainable information. A differential consideration of local and remote, direct and indirect, clinical and roentgen findings is presented which should materially reduce our diagnostic failures.

The above description may make it appear that the diagnosis of so-called "chronic appendicitis" is always a very complicated matter, but in most of the cases a diagnosis can be easily established with more than a fair degree of certainty.

ILLUSTRATIVE CASE

About four years ago this patient (Dr. F. K. S.) had an attack of what was termed "intestinal flu" — slight fever, nausea, abdominal cramps, constipation following diarrhea. Since then he has been troubled with periods of faulty digestion. The symptoms were distress in the epigastrium, flatulence, and a general feeling of distention. This condition was apparently worse after heavy, especially greasy, meals. At times there was a little "burning," which came late, after meals. Reduction in food intake brought about almost complete relief.

Findings are those of a definitely irritated appendix, with many of the symptoms probably due to secondary reflex phenomena. The general irritability of the entire gastro-intestinal tract is characteristic.

The stomach presents several points of interest (Fig. 1). We see an irritable stomach: at times the peristalsis is very ac-

tive and the stomach empties rapidly for a while, but the emptying is generally in the end delayed slightly by intermittent pylorospasm. The peristalsis is not the regular

Fig. 2. The 6-hour film. See text.

deep regular active peristalsis we so frequently find with ulcer of the cap. We frequently find a lack of gastric motility throughout. The cap in this case shows the fibrillary spasms which may be easily pressed out on palpation. The findings are similar to those described for duodenitis. Duodenal stasis, "puddling," and reverse peristalsis are frequent. The usual duodenal finding at operation is "nothing," although we may find some of the findings described as "duodenitis." The "duodenitis," in my mind, may be looked upon in most cases more as a result or symptom, with some other condition, as a pathologic appendix, colon, gall bladder, pelvic inflammatory condition, etc., as the real difficulty.

The six-hour film (Fig. 2) shows a frequent finding—slightly delayed stomach emptying. The advance in the colon may be more rapid and the evidence of a delay in the final emptying may be more pronounced. Often when there is a more active

Fig. 3. The 24-hour film. See text.

inflammatory process in the appendix we may even find a gastric residue at six hours.

The 24-hour film (Fig. 3) shows several things of interest. First, we have the irregularly filled appendix, with its tip adherent to the ascending colon, and tender to palpation. We find a rather marked general irritability of the colon, as shown by abnormal haustration. We frequently find more proximal colon clearing. It is my contention that this colonic irritability is often more responsible for the epigastric distress (reflex?) than the actual appendiceal condition which initiates this colonic state. Again, the proximal colon, which is so important in the absorption of digested food products, is not capable of giving "good service" when in such a highly irritable state, and intestinal gas and a feeling of distention result. The term "allochiria,"

meaning pain reflexly referred to the side opposite the trouble, often does not apply. I am inclined to believe that colonic spasm, often more marked at the points of the different colonic valves (Hirsch, Busi, and others), can easily account for the pain symptoms on the opposite side of the abdomen. This colonic irritability, manifested in several ways, is generally found when there is appendiceal irritation, but is by no means pathognomonic of an irritated appendix.

Fig. 4. The 48-hour film. See text.

The 48-hour film (Fig. 4) shows the same degree of colonic spasm with otherwise normal emptying. Stasis at the cecal tip is occasionally found. The appendix shows a certain degree of stasis in most cases in which it is patent, although an irritated appendix tip may cause rapid emptying of the proximal end. The appendiceal shadow of barium narrows irregularly due to absorption of fluid and may eventually form the center of a somewhat inspissated core. New material flows into the appendix circumferentially about this appendiceal core by a mere process of appendiceal dilatation, just as we find in the colon. This circumferential advance of the liquid contents from the small bowel in the colon brings the liquid contents in contact with a maximum surface of absorbing colonic epithelium, thus hastening the withdrawal of fluid, with its nutritive products.

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ATYPICAL BONE TUMORS[1]

WITH PRESENTATION OF TWO CASES

By K. S. DAVIS, M.D., M.S. in Roentgenology, Los Angeles, California

IN the diagnosis of bone tumors there are many borderline and atypical lesions which are not clear-cut either roentgenologically or pathologically. There are instances in which it is almost impossible to decide whether the lesion is benign, malignant, or inflammatory on the basis of the roentgenographic and clinical findings alone.

The two cases included in the present report illustrate very well the difficulties encountered in making a correct diagnosis in the unusual and atypical bone tumor.

Case 1. The patient, a male, 35 years of age, was admitted to St. Vincent's Hospital September 30, 1929, because of a fracture of the left humerus. Three years previously the left shoulder and humerus became painful following vaccine therapy for a chronic neisserian infection. Since that time the patient had had repeated attacks of pain of increasing severity in the same area. In May, 1929, the symptoms became very much aggravated following a fall on the left shoulder, with almost continuous pain since then. September 19, 1929, the humerus suddenly fractured while he was carrying a case of films.

The roentgenogram made at the time of his admission to the hospital showed a pathologic fracture in the middle third of the shaft of the left humerus. The entire upper half of the humerus including the head and neck showed a mottled, diffuse rarefaction, and the diameter of the bone was increased about 50 per cent over normal, although this increase in size did not appear to be due to a true expansion of the cortex. The cortex, while thinned out, was still intact except at the site of the fracture. There was no soft-tissue swelling or any demonstrable periosteal proliferation noted (Fig. 1).

Roentgenograms were made of practically all the other bones, all of which appeared to be normal in structure.

Subsequent roentgenograms of the left humerus showed, in addition to the changes noted above, a periosteal proliferation and an extension of the process into the soft tissues surrounding the humerus. The soft-tissue tumor was first noted near the site of the fracture; later the entire upper half of the arm became involved (Figs. 2 and 3).

X-ray treatments were commenced December 4, 1929, and continued until December 26, 1929. During the course of the treatments the growth remained stationary in size but there was not the regression of the tumor which we had expected.

In January, 1930, the patient, learning of the Coffey-Humber serum, left our care and went to San Francisco. There he was given a series of serum treatments over a period of seven weeks. During this time there was a rapid growth of the tumor, which soon became very large. The patient failed rapidly and died two weeks after his return home.

The autopsy, done on March 10, 1930, showed a tumor of the left arm involving the bone, soft tissues, and skin. The greater portion of the upper half of the shaft of the humerus was missing, there being only a few small, eggshell-like fragments of the cortex embedded in the tumor. The head of the humerus was filled with gelatinous necrotic material but the shoulder joint and scapula were not involved. The tumor was very soft, gray in color, and intact in portions; other parts were yellow and necrotic

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Fig. 1. Case 1. Roentgenogram taken at the time of admission to St. Vincent's Hospital. The extent of the tumor, the increased diameter of the bone, the thinned but intact cortex, and the pathologic fracture are the outstanding findings in this film.

Fig. 2. Case 1. A subsequent roentgenogram showing the periosteal proliferation. At the time this film was made there was a marginal union between the fractured fragments.

and some were gelatinous. There was no involvement of the soft tissues of the axillary space.

The abdominal cavity contained about two liters of blood, fluid and in clots. The liver was greatly enlarged, containing many tumor masses of varying size. Many of the masses were necrotic; in one of the tumors there was a definite hemorrhagic necrotic mass which had broken through the capsule and accounted for the free blood found in the peritoneal cavity. Metastases were also present in the head of the pancreas, retroperitoneal lymph nodes, and lungs.

Sections of the humerus, the soft-tissue tumor of the arm, and the metastases showed a highly cellular, large spindle-cell tumor. Many cells were elongated and had compact dark staining nuclei. Mitotic figures were abundant. In the head of the humerus there was an extensive mucinous degeneration and necrosis. Necrosis was also present in irregular areas throughout the entire tumor mass.

Dr. G. D. Maner, who performed the autopsy, made a microscopic diagnosis of periosteal sarcoma with generalized metastases.

Sections of the tumor were sent to Dr. James Ewing, whose report is as follows: "You have sent me material from a very remarkable bone tumor. Most of the sections show a structure which might well be an osteogenic sarcoma. The cells are very large and spindle, although some are large and polyhedral. There is a good deal of degenerating soft cartilage which does not seem to belong to the tumor process. There is a section of peculiar reticulated tissue which I cannot explain. It looks somewhat like thyroid tissue. In portions of the tumor there are very numerous, perfectly well

formed acini, which show that the tumor must be some form of metastatic carcinoma.

"I think this tumor must be a metastatic carcinoma from some source. The radiograph is characteristic of a very destructive metastatic carcinoma. The tumor cells are too large and spindle for endothelial myeloma. Alveoli are not present in endothelioma."

Sections were also sent to Dr. A. C. Broders at the Mayo Clinic, who diagnosed the tumor as a rhabdomyosarcoma.

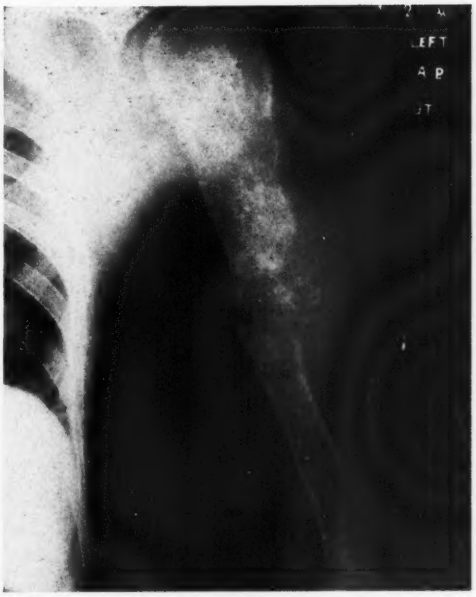

Fig. 3. Case 1. Roentgenogram taken after the tumor had spread to the soft tissues. This was first noticed at the site of the fracture. Later the entire upper half of the arm became involved.

COMMENT

In this case we have a bone tumor, medullary in origin, involving the upper half of the shaft of the humerus, causing a marked increase in the diameter of the bone. In the first roentgenogram the cortex showed a mottled, diffuse rarefaction but was intact except at the site of the pathologic fracture. Later there was noted a roughening of the periosteum, which periosteal proliferation did not have the radiating spicules of osseous tissue perpendicular to the shaft as seen in a typical periosteal osteogenic sarcoma. The spread of the tumor into the surrounding soft tissues apparently occurred first at the site of the fracture. Intensive X-ray treatments caused a cessation of the tumor growth but no regressive changes were observed during the treatments. During the period in which the Coffey-Humber serum was given the tumor increased rapidly in size, with progressive constitutional symptoms until death ensued.

Case 2. R. F., a well developed male, 67 years of age, first presented himself for examination in September, 1928. He complained chiefly of pain and a tumor on the anterior part of the left leg about ten inches below the knee. In March, 1927, the patient had fallen, tripping over a tight wire, and injured his left leg over the tibia. The swelling appeared immediately after the injury and had persisted since that time. The pain, which consisted of a dull ache in the affected leg, had been intermittent in character, disappearing when the leg was at rest and reappearing when the patient resumed his normal activities—motoring and golf. His general health had always been excellent. The Wassermann test had been repeatedly negative, even after provocative salvarsan had been given.

ROENTGENOGRAPHIC FINDINGS

The first roentgenogram, taken October 4, 1927, showed a fairly circumscribed area of diminished bone density about 3×4 centimeters in diameter in the cortex of the left tibia. The lesion was apparently cortical in origin, expanding and thickening the cortex and partially obliterating the medullary cavity but with no evidence of direct involvement of the medulla. Above the main lesion

Fig. 4. Case 2. Antero-posterior roentgenogram taken soon after patient's injury. Note the cortical area of diminished bone density, with an expansion of the periosteal surface of the cortex but no thinning.

Fig. 5. Case 2. Antero-posterior roentgenogram taken a year later. The tumor has increased in size but is still sharply delimited. The cortex is expanded but not thinned. The bone surrounding the tumor is denser than in the previous film. (Compare with Figure 4.)

there were three intracortical areas of rarefaction lying just beneath the periosteal surface of the cortex (Figs. 4 and 6).

From October, 1927, until February, 1930, numerous roentgenograms were made, these showing a slow progressive development of the lesion described above.

The development consisted of: (1) A gradual increase in the size of the central area of rarefaction; (2) an expansion of the cortex, which became thickened instead of thinned; (3) a coalescence of the three upper lesions which, however, remained definitely divided, appearing as three lesions adjacent to each other but not merged; (4) appearance of periosteal new bone with a rather characteristic parallel cortical striation of the newly formed bone (Figs. 5 and 7).

At this point a tentative diagnosis of Ewing's tumor was made and the patient referred to Dr. Albert Soiland for X-ray therapy. A series of ten X-ray treatments were given, beginning October 15, 1928.

On May 15, 1929, a series of radium applications was given over the anterior part of the left leg. Twelve applications were given, using radium filtered by 1 mm. of brass and applied at a distance of 3 centimeters—a total of 4,260 milligram-hours.

In spite of the radiation and radium therapy the lesion continued to progress slowly in size, although, in the opinion of the essayist, it showed a distinct increase in the density of the surrounding cortex following the X-ray treatments. The patient stated that the bone felt "stronger" although the pain was still felt when he played golf.

Fig. 6. Case 2. Lateral roentgenogram taken in 1928. In this film there can be seen the main tumor with three adjacent intracortical areas of rarefaction lying above the main tumor just beneath the anterior periosteal surface of the cortex.

Fig. 7. Case 2. Lateral roentgenogram taken two years later. (Compare with Figure 6.) Following the X-ray and radium treatments the cortical bone surrounding the bone tumor showed a distinct increase in density. There is a coalescence of the three small lesions seen in early roentgenograms.

Roentgenograms of practically all the other bones failed to show demonstrable evidence of involvement.

Because of a sharply divided difference of opinion between the local radiologists in Los Angeles, roentgenograms were sent to Dr. G. H. Holmes, of Boston, Dr. B. R. Kirklin and Dr. M. S. Henderson, of the Mayo Clinic, and Dr. Ralph E. Herendeen and Dr. James Ewing, of New York City. It was the opinion of all of these men that the process should be classified as an inflammatory lesion rather than a neoplasm, and an exploratory operation was advised. This was done on May 15, 1930, by Dr. John Wilson, whose surgical report is as follows: "An extremely vascular tumor, with softening of the cortical bone. A wedge-shaped piece of tissue $4 \times 2 \times 2$ cm. was removed for biopsy. The cortical portion of the bone tumor is very hard and somewhat eburnated; beneath this a soft grayish tumor can be seen between the bony spicules."

Frozen sections of the softer parts of the tumor showed a cellular fibrous tissue stroma surrounding irregular spaces, lined by atypical high columnar epithelium often two or more rows deep. Microscopic diagnosis: metastatic carcinoma of the tibia.

The amputated leg showed a bulbous enlargement of the tibia due to a bone tumor measuring $12 \times 6 \times 5$ centimeters. The marrow cavity was obliterated by cancellous bone, the spaces of which were filled with a grayish tumor. There was a small tumor, similar in appearance, lying above the main tumor. The soft parts were not involved.

Microscopic sections were sent to Dr. Wil-

Fig. 8. Case 2. Roentgenogram made of the tumor after amputation of the leg. The extent of involvement is best illustrated here.

liam Ophuls, of Stanford University, Dr. A. C. Broders, at the Mayo Clinic, and Dr. Ewing, of New York City, all of whom agreed as to the diagnosis.

COMMENT

In this case we have a localized metastasis to the left tibia in a patient whose general health has always been excellent. The roentgenographic appearance was certainly not indicative of such an involvement. A careful history and thorough physical examination failed to reveal any possible primary source for the metastatic growth. Roentgenograms of practically all the other bones in the body were negative for demonstrable involvement. The lesion was extremely slow in its growth and showed as much bone proliferation as destruction. It was sharply delimited, never showing any tendency to invade the surrounding bone or soft tissue. At the present time (December, 1930) the patient's general health is still excellent and he shows no evidence of a malignant lesion in any part of the body.

DISCUSSION

Dr. John C. Wilson (Los Angeles, Calif.): The first patient (Case 1), when he came under our observation, appeared to be suffering from a benign lesion resembling osteitis fibrosa cystica. A possibility of a bone lesion associated with leukemia or splenic anemia was also considered. The presence of a malignant tumor was not suspected until a rapidly growing soft-tissue tumor appeared at the site of the pathologic fracture. Because of the fact that this patient had a claim under dispute before the Industrial Accident Commission it was not possible to undertake any surgical treatment until the condition was obviously inoperable. It is interesting to note the extreme rapidity with which this tumor grew and metastasized after treatment with the Coffey-Humber extract.

Regarding the second case, a word of explanation should be offered to account for the rather unusual procedure of amputation for bone carcinoma, presumably metastatic. The slow growth and circumscribed nature of the lesion, its steady progress in spite of radiotherapy, the patient's excellent general condition, and the absence of a demonstrable primary lesion made us feel that amputation might offer a prolongation of life in addition to relief from the troublesome local symptoms. The exploratory operation undertaken on the advice of consultants rendered the amputation imperative.

Cases such as these, in which conflicting opinions by the radiologists and pathologists are added to inconclusive clinical findings, place a grave burden of responsibility on the surgeon.

THE RADIOLOGICAL STUDY OF THE STOMACH AND DUODENUM, WITH SPECIAL REFERENCE TO THE VALUE OF THE LATERAL VIEW[1]

By SAMUEL BROWN, M.D., CINCINNATI, OHIO

THE value of the lateral view of the stomach and duodenum is, in my opinion, not fully appreciated by radiologists at large. This is evidenced by the infrequent reference to its use in the X-ray literature and also by the total absence of illustrations of the lateral view of the stomach and duodenum in standard books dealing with the radiological diagnosis of gastro-intestinal lesions. The chief reason for the lack of interest in the use of the lateral view is the assumption that any lesion affecting the stomach or duodenum which can be demonstrated radiologically can be shown in the usual anterior view. This is indeed true for the majority of lesions, but not for all, in my experience. Time and again I have found that the lateral view, either left or right, has enabled me to demonstrate the presence of a lesion absolutely impossible of such demonstration in the usual anterior view.

The study of the normal stomach and duodenum in the lateral positions has been the subject of several of my previous publications (1, 2, 3). In the present communication I will confine myself to a brief discussion of the anatomical and physiological characteristics of the stomach and duodenum, together with several brief case reports accompanied by illustrations in the anterior and lateral views.

1. The position, shape, and size of the stomach and duodenum depend a great deal upon the habitus and age of the individual. Before any conclusions are drawn these data concerning the individual under examination should be taken into consideration.

2. The stomach and duodenum are, relatively speaking, freely movable organs, and, as such, their position and shape will to a large degree depend upon the position of the body as a whole.

3. The stomach and duodenum are elastic organs and therefore capable of expansion. Thus, their size, shape, and position will depend upon the quantity of food ingested.

4. The stomach and duodenum are muscular organs and therefore possess capacity for contraction and relaxation. Thus their position, shape, and size will depend upon the muscular tone, upon the degree of peristalsis, and upon the rate of emptying.

5. A knowledge of the shape of the normal stomach and duodenum in the several standard positions, namely, dorsal, ventral, left and right lateral, is important in order to be able to recognize any deviation from the normal contour.

6. The position and shape of the stomach and duodenum are subject to alteration as a result of changes in the size and position of the neighboring organs, such as the liver, spleen, kidneys, pancreas, and pelvic organs. Thus a knowledge of the normal relations which exist between the stomach and duodenum and their neighboring organs both in the antero-posterior and lateral positions is essential in order to recognize any abnormal change in the neighboring structures.

7. The size or volume of the stomach depends upon its length, breadth, and depth. Only by the use of the antero-posterior and lateral views can one obtain a fair idea of

[1]Read before the Radiological Society of North America, at the Sixteenth Annual Meeting, at Los Angeles, Dec. 1–5, 1930.

Fig. 1-*A* (anterior view). No deformities are present on the lesser or greater curvature.

Fig. 1-*B* (left lateral view). Marked deformity involving the cardiac end of the stomach.

the actual size of the stomach. It is generally found that the so-called small "steer-horn stomach" has greater depth than the "fish-hook stomach" when they are studied in the lateral position. In other words, the steer-horn or transverse type of stomach makes up in depth what the fish-hook type of stomach makes up in length.

8. Foreshortening of the stomach in the anterior view may occur in the steer-horn or transverse type of stomach. This is due to the fact that the stomach does not lie parallel with the abdominal wall, but at an angle, with the direction of its axis from before backwards. Foreshortening of the stomach is more apt to occur in pathological stomachs than in normal ones, because of scar tissue or adhesions. In the lateral view it is often possible to overcome this difficulty and expose the entire contour to view.

9. In the transverse type of stomach the duodenal bulb is frequently located behind the pylorus and thus obscured from view, and its study is naturally made difficult. In the right lateral view the duodenum can be exposed in its entire course and any abnormal changes can be noted.

10. Deformities in the contour of the stomach and duodenum can be recognized so long as they occur at the periphery of the X-ray shadow. It is evident that, if a deformity involves the anterior or posterior walls of the stomach or duodenum, the patient should be placed in such a position that the anterior and posterior walls will be at the periphery of the X-ray shadow. This position is either the left or right lateral.

11. The duodenojejunal flexure is located beneath the body of the pancreas: in the vertical stomach it is often seen above the lesser curvature. In the transverse stomach it is usually found to be obscured by the

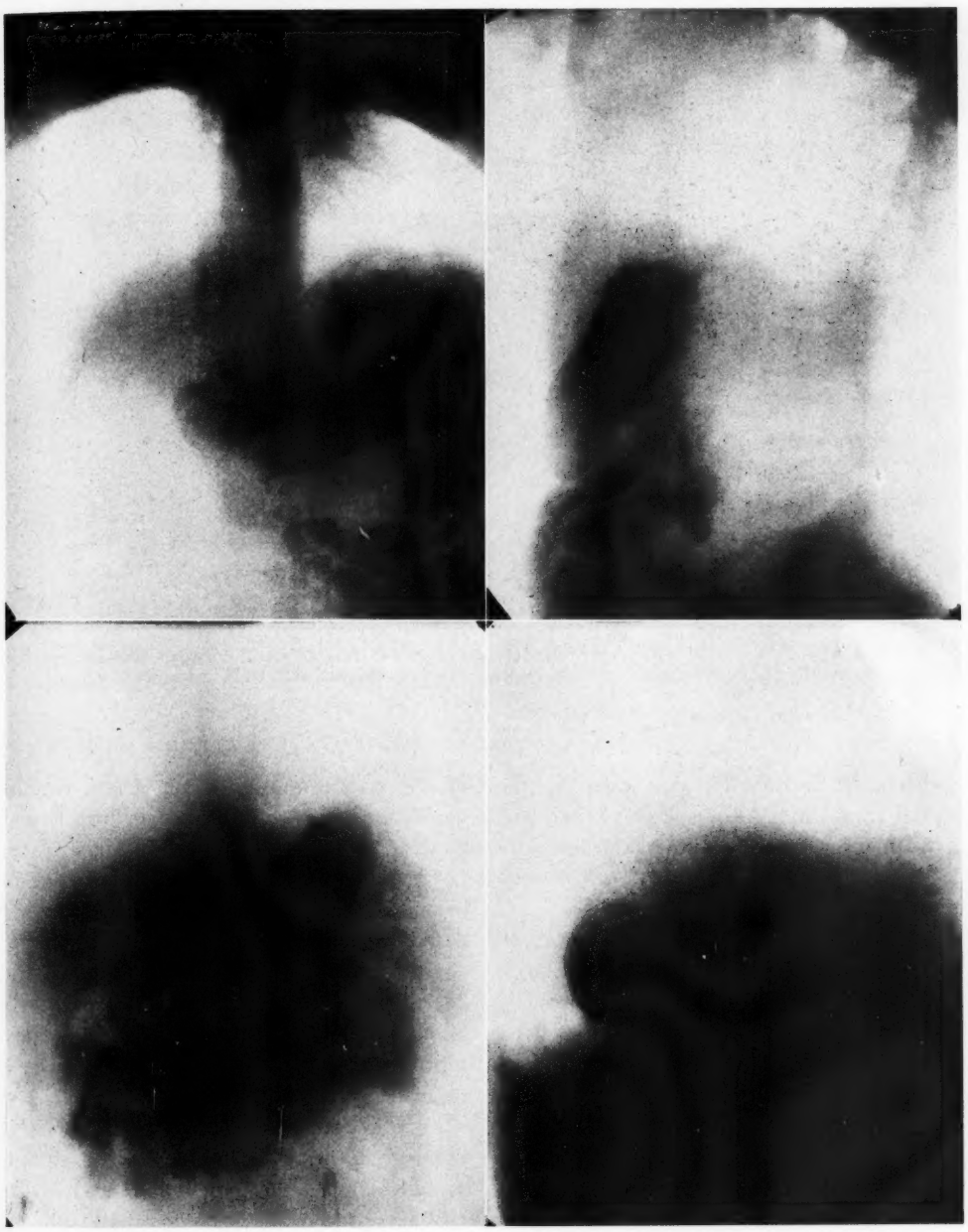

Fig. 2-*A* (anterior view). The lesser and greater curvatures present no deformities in contour. *(Upper left.)*

Fig. 2-*B* (left lateral view). Considerable deformity involving the upper half of the posterior wall of the stomach. *(Upper right.)*

Fig. 3-*A* (anterior view). No deformities are present on the lesser or greater curvature of the stomach. *(Lower left.)*

Fig. 3-*B* (right lateral view). Marked deformity involving the middle third of the stomach. *(Lower right.)*

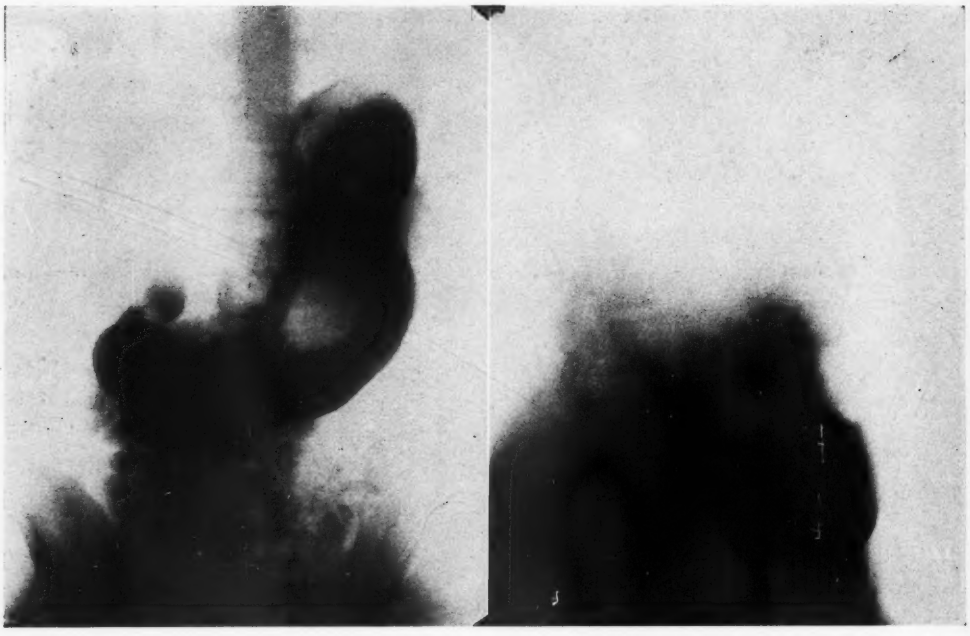

Fig. 4-*A* (anterior view). Circumscribed defect in the middle of the stomach.

Fig. 4-*B* (right lateral view). The deformity involves the anterior wall of the stomach.

stomach, or it may be seen close to the greater curvature. A considerable separation between the greater curvature and the duodenojejunal flexure should lead one to suspect a possible pancreatic tumor.

12. Artificial deformities of the stomach and duodenum as a result of outside pressure exerted upon their walls are usually considered a hindrance in the study of these structures. However, these deformities possess certain advantages in directing one's attention to something abnormal within the abdominal cavity. By a process of differentiation one can readily determine the true cause of the deformity.

(a) A deformity which is due to a tumor within the stomach will accentuate the abnormal shadow when the patient lies flat on the abdomen, and very often displaces all the barium between the anterior and posterior walls of the stomach. The exact extent of the tumor and its exact origin can be determined only by the use of the lateral view.

(b) A deformity of the stomach due to pressure by a mass between the stomach and the anterior wall of the abdomen will disappear when the patient is studied in the lateral position; however, the stomach will be found displaced backwards and the anterior wall of the stomach will present a regular crescent-shape compression.

(c) A deformity of the stomach due to pressure by a mass behind the stomach will disappear when the patient is placed in the lateral position, but the stomach will be found to be displaced forward and the posterior wall to be compressed.

(d) A deformity of the stomach due to extra-abdominal pressure will disappear when the patient is placed in the lateral position. In this case the walls of the stomach

will bear a normal relation to the abdominal wall and spine.

13. The position and shape of the stomach are often influenced by palpable or non-palpable tumors within the abdominal cavity. The following process of differentiation has been found of great service.

(a) A tumor originating from the stomach will seldom change the position of the stomach. The deformity in the contour of the stomach, whether visible or non-visible in the anterior view, can always be demonstrated in either the left or right lateral view.

(b) A splenic tumor will displace the stomach and duodenum to the right and forward and the splenic flexure downward.

(c) A liver tumor will displace the stomach and duodenum to the left and backward.

(d) Right kidney tumor will displace the stomach and duodenum to the left and forward.

(e) Left kidney tumor will displace the stomach and duodenum to the right and forward.

(f) Pancreatic tumor will displace the stomach forward and if any lateral displacements occur the stomach and duodenum will be displaced in opposite directions. The duodenojejunal flexure is often found to be displaced downward by pancreatic tumors.

(g) Retroperitoneal tumors originating from the retroperitoneal glands behind the stomach will displace the latter forward. The position of the duodenojejunal flexure is not affected.

CASE REPORTS

Case 1 (Figs. 1-*A* and 1-*B*). Male, age 54, complained of a moderate degree of gastric distress, with marked anemia. Clinically there was a strong suspicion of gastric cancer. X-ray examination of the stomach elsewhere had failed to confirm this suspicion. In my examination I found the stomach free from any deformities in the anterior view (Fig. 1-*A*). In the left lateral view (Fig. 1-*B*) an extensive deformity was found to involve the cardiac end of the stomach. The diagnosis of carcinoma was confirmed by operation.

Case 2 (Figs. 2-*A* and 2-*B*). Male, age 66, presented symptoms suggestive of cancer of the stomach. In the anterior view (Fig. 2-*A*) no filling defects were noticed in the contour of the lesser and greater curvatures. In the left lateral view (Fig. 2-*B*) an extensive deformity was noticed along the posterior wall of the stomach in its upper third. A diagnosis of cancer of the stomach was confirmed by operation at the Mayo Clinic.

Case 3 (Figs. 3-*A* and 3-*B*). Male, age 59, had complained of gastric disturbances for over a year. During this time he had been submitted to several X-ray examinations of the stomach by various radiologists, but without finding any abnormal changes. His condition gradually became worse from loss of blood by rectum. He was examined by me after he had been admitted to the hospital and after several blood transfusions had been done. I found no deformities involving the lesser or greater curvatures in the anterior view (Fig. 3-*A*). In the right lateral view (Fig. 3-*B*) a large deformity was noticed, involving the middle portion of the stomach. A diagnosis of cancer of the stomach was confirmed by operation and a microscopic section.

The above three cases illustrate the possibility of failing to make a correct diagnosis if one is to depend upon the study of the stomach in the antero-posterior position alone. The third case is the most remarkable because of the existence of an extensive deformity which showed not the slightest change in contour in the anterior view.

The value of the lateral view is also

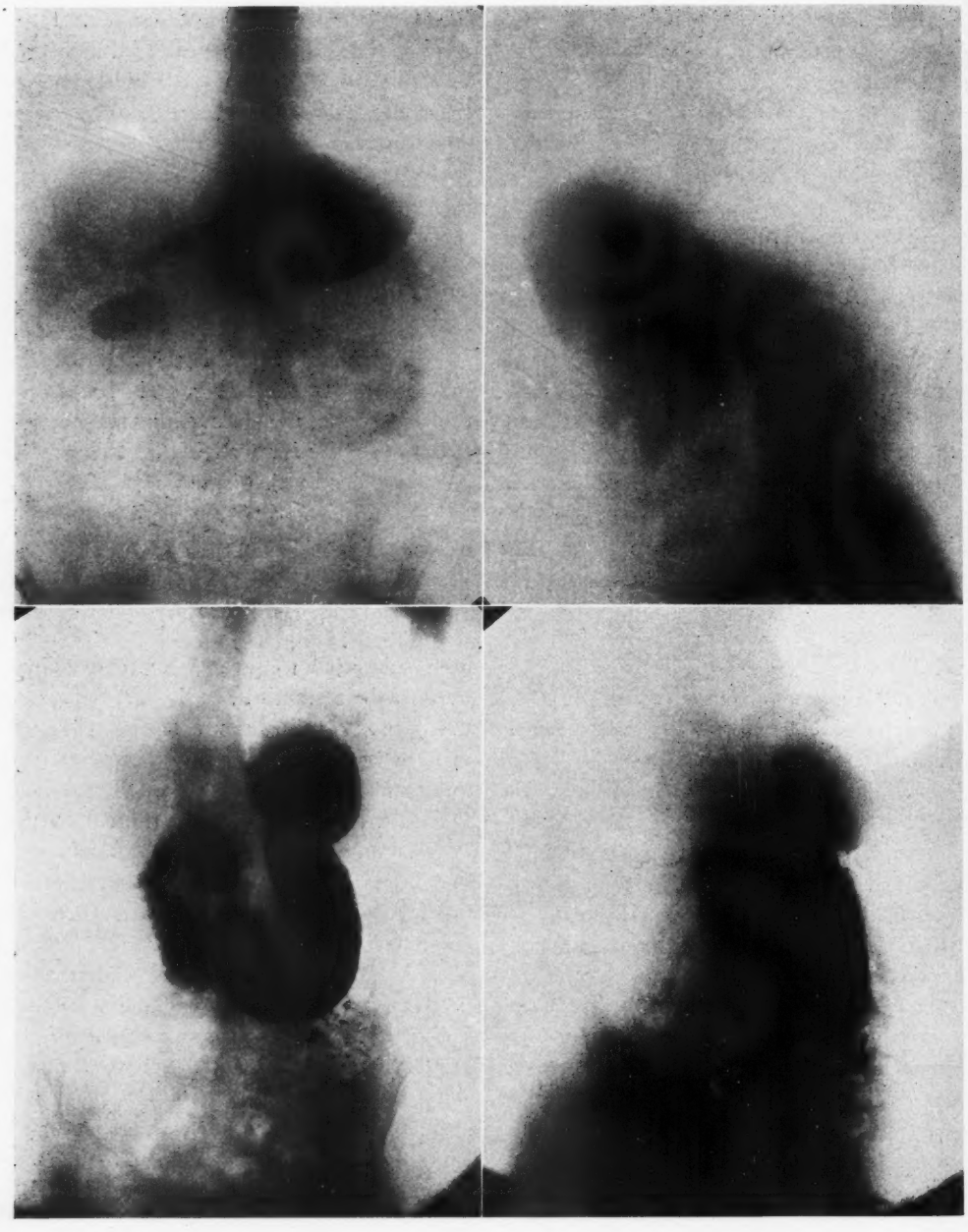

Fig. 5-*A* (anterior view). Circumscribed filling defect of the pylorus. *(Upper left.)*
Fig. 5-*B* (right lateral view). The filling defect involves the anterior wall of the pylorus. *(Upper right.)*
Fig. 6-*A* (anterior view). Hour-glass indentation of the upper end of stomach. *(Lower left.)*
Fig. 6-*B* (right lateral view). Niche is shown on the posterior wall opposite the constriction of the greater curvature. *(Lower right.)*

shown when it is desired to determine the exact origin of a tumor which is recognizable in the usual anterior view. The following two cases will illustrate this point.

Case 4 (Figs. 4-*A* and 4-*B*). Female, age 43, had complained of gastric distress for more than two years. At the time of the onset of her illness she was subjected to an X-ray examination of the stomach, with the diagnosis of a duodenal ulcer. She was treated for that lesion, but without any improvement. A subsequent X-ray examination of the stomach revealed a large circumscribed filling defect in the middle of the stomach (Fig. 4-*A*). In the lateral view (Fig. 4-*B*) the anterior wall of the stomach appears to be the origin of the newgrowth. A diagnosis of benign tumor was confirmed by operation and microscopical section.

Case 5 (Figs. 5-*A* and 5-*B*). Male, age 70, complained of gastric disturbances suggestive of cancer of the stomach. In the anterior view (Fig. 5-*A*) a large filling defect is shown to involve the whole of the pylorus. In the right lateral view (Fig. 5-*B*) only the anterior wall of the stomach is seen to be involved. This was confirmed by operation.

Case 6 (Figs. 6-*A* and 6-*B*). Female, age 48, had presented gastric symptoms for several years. In the anterior view (Fig. 6-*A*) an indentation of the greater curvature is seen, but no niche on the lesser curvature corresponding to the region of the hourglass constriction. In the right lateral view (Fig. 6-*B*) a characteristic niche deformity is seen on the posterior wall.

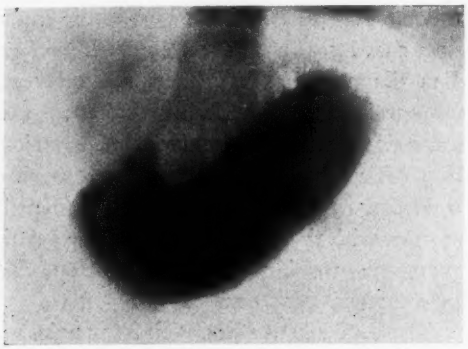

Fig. 7-*A* (anterior view). No filling defects are shown on the lesser or greater curvature of the stomach or duodenum.

Fig. 7-*B* (right lateral view). The posterior wall of pylorus presents a filling defect, and the duodenal bulb is deformed.

Case 7 (Figs. 7-*A* and 7-*B*). Male, age 47, had complained of gastric disturbances for several years. In the anterior view (Fig. 7-*A*) no deformities were noticed in the contour of the lesser or greater curvatures. In the right lateral view (Fig. 7-*B*) a distinct filling defect is seen on the posterior wall of the pylorus. The duodenal bulb shows an irregular outline of its anterior wall. A diagnosis of pyloric ulcer

with duodenal adhesions was confirmed by operation.

Case 8 (Figs. 8-*A* and 8-*B*). Male, age 30, presented a typical history of gastric ulcer. In the anterior view (Fig. 8-*A*) no filling defects were noticed in the contour of the stomach. The duodenal bulb could not be seen because it was lying behind the pylorus and was thus obscured from view. In the right lateral view (Fig. 8-*B*) a distinct niche is seen on the posterior wall of the stomach. Its presence was constant and it failed to disappear during a peristaltic wave. The duodenal bulb presented a distinct shadow of a niche on its upper surface. The diagnosis of a gastric and duodenal ulcer was made. The failure to demonstrate these deformities in a subsequent examination after an interval of several months, following a rigid medical and dietetic régime, with the disappearance of the gastric symptoms, would lead one to conclude that the diagnosis was correct.

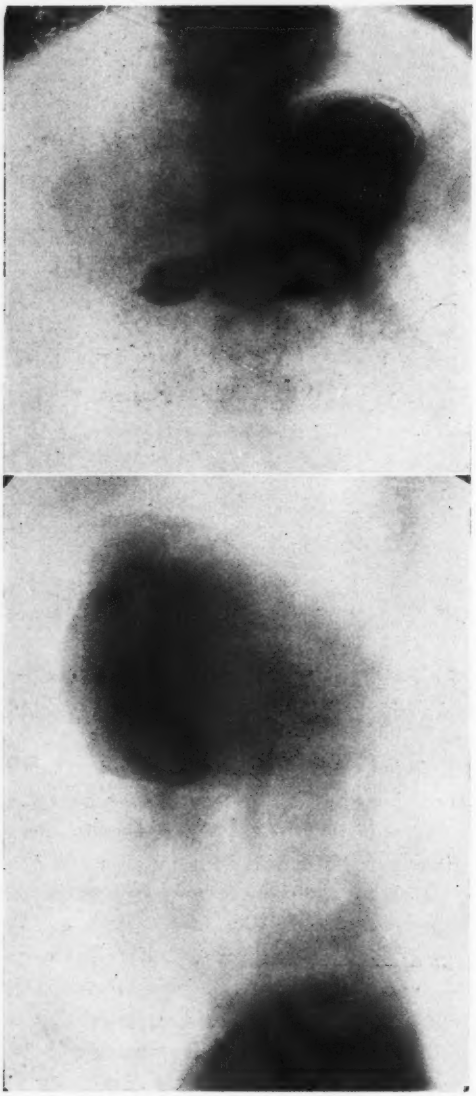

Fig. 8-*A* (anterior view). No filling defects are seen on the lesser or greater curvature. The duodenal bulb is obscured by the pylorus. *(Top.)*
Fig. 8-*B* (right lateral view). The posterior wall of the stomach presents a niche. The duodenum is shown in its entire course. The upper surface presents a niche. *(Bottom.)*

Case 9 (Figs. 9-*A* and 9-*B*). Female, age 63, complained of gastric symptoms suggestive of cancer of the stomach. The anterior view (Fig. 9-*A*) failed to show any deformities in the contour of the stomach. The duodenal bulb was found entirely obscured by the pylorus. In the right lateral view (Fig. 9-*B*) a small niche was seen to arise from the upper surface of the bulb. A diagnosis of duodenal ulcer was confirmed by operation.

The above four cases illustrate the possibility of overlooking the existence of an ulcer of the stomach or duodenum if it does not happen to be located on the lesser or greater curvature. In the case of the duodenum another factor enters in, rendering the diagnosis of ulcer difficult: the bulb is often located behind the pylorus and thus its study is made impossible. In the right lateral view the entire course of the duodenum can be demonstrated and any abnormal changes can readily be noted.

Thus far, lesions of the stomach and duodenum of intrinsic origin have been discussed. I shall now present several cases of extrinsic origin affecting the stomach and duodenum.

Fig. 9-*A* (anterior view). No filling defects are seen on the lesser or greater curvature. The duodenal bulb is obscured by the pylorus.

Fig. 9-*B* (right anterior view). Niche is shown on the upper surface of the duodenum.

Case 10 (Figs. 10-*A* and 10-*B*). Female, age 57, was examined elsewhere and obstruction was found in the region of the duodenojejunal junction. This was considered to be due to a newgrowth arising from within the bowel. In my examination I confirmed the same findings (Fig. 10-*A*); however, it was also noticed that the duodenojejunal flexure was displaced downward and the pyloric end displaced upward. The greater curvature of the pylorus presented an ill-defined contour. In the left lateral view (Fig. 10-*B*) the stomach was found to be displaced upward and forward. It has been my experience that the position of the stomach seldom changes from a growth originating inside itself or the duodenum, hence, I reasoned, the displacement must be due to a growth originating outside the stomach and duodenum. Since the relation between the stomach and duodenojejunal flexure has been found altered, and such an alteration can be produced only by the body of the pancreas, because it lies just above the bowel, a diagnosis of cancer of the pancreas was made. This was confirmed by operation and, several days later, by a postmortem examination.

Case 11 (Figs. 11-*A* and 11-*B*). Male, age 45, had complained of pain in the epigastrium and back for several months before admission to the hospital. An X-ray examination of the gastro-intestinal tract made elsewhere failed to reveal anything abnormal. In my examination I found a distinct deformity along the greater curvature of the stomach, but not involving the latter (Fig. 11-*A*). The duodenojejunal flexure was found to be displaced downward. In the left lateral view (Fig. 11-*B*) the stomach was found to be displaced upward and forward. The posterior wall of the stomach was found to be ill defined. By the same process of reasoning as applied in

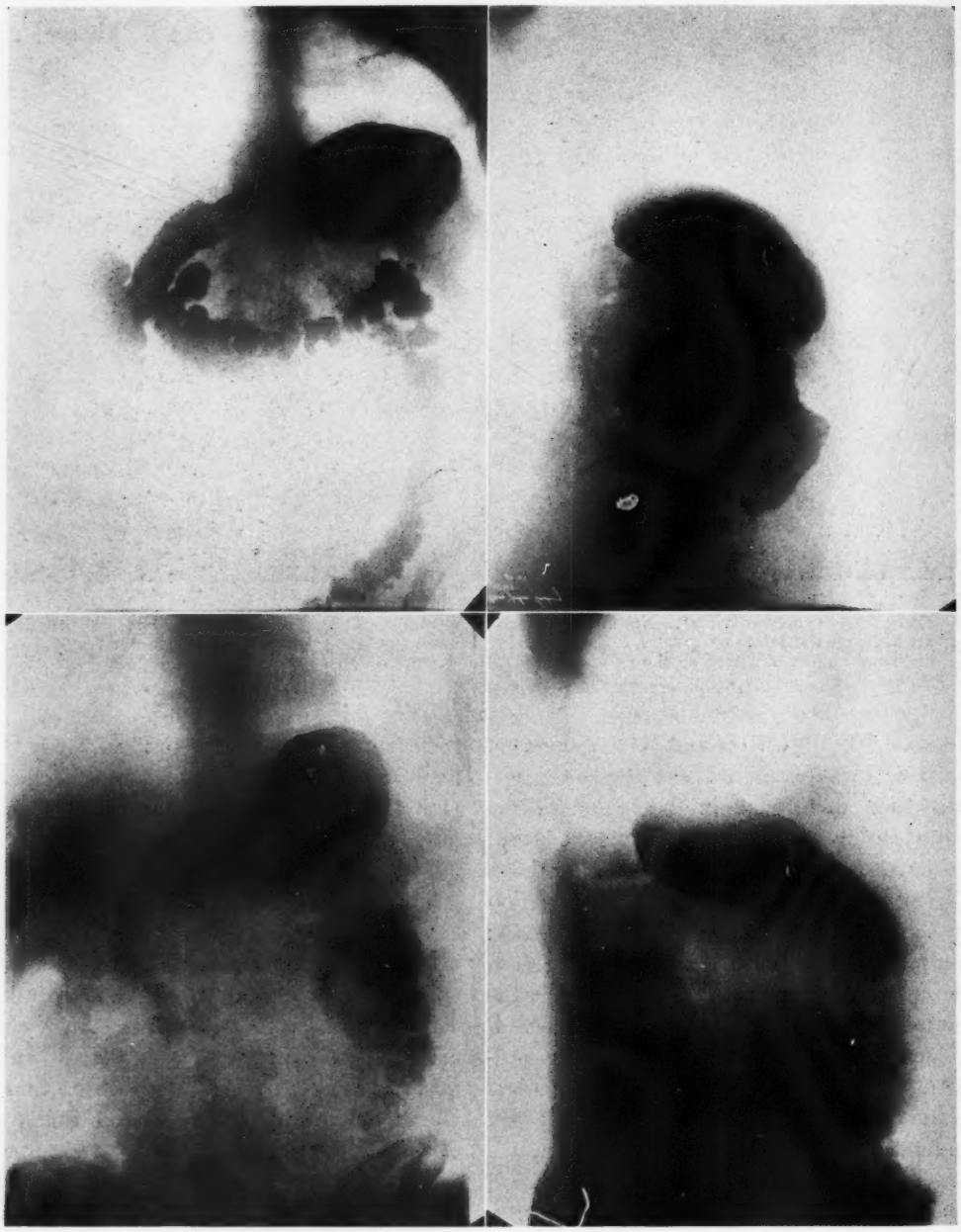

Fig. 10-*A* (anterior view). The greater curvature of the pylorus is ill defined. The duodenojejunal flexure is displaced downward and is obstructed. *(Upper left.)*

Fig. 10-*B* (left lateral view). The stomach is displaced upward and forward due to a pancreatic tumor. *(Upper right.)*

Fig. 11-*A* (anterior view). A deformity along the greater curvature of the stomach. The duodenojejunal flexure is displaced downward. *(Lower left.)*

Fig. 11-*B* (left lateral view). The stomach is displaced upward and forward. The posterior wall is deformed due to a pancreatic tumor. *(Lower right.)*

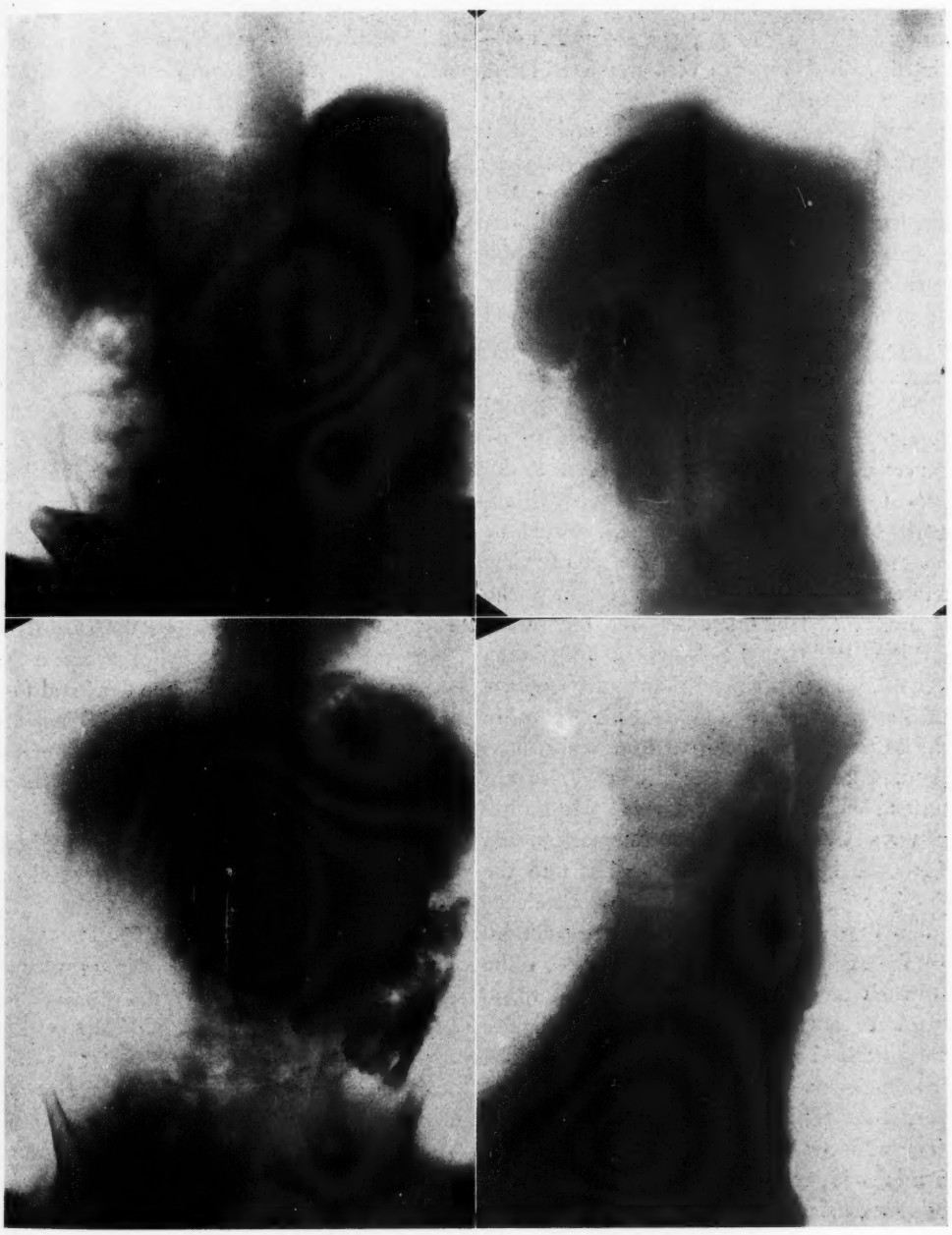

Fig. 12-*A* (anterior view). The pyloric end is obliterated. The stomach is displaced to the left and the duodenum to the right. *(Upper left.)*

Fig. 12-*B* (right lateral view). The stomach and duodenum are displaced forward due to a retroperitoneal tumor. *(Upper right.)*

Fig. 13-*A* (anterior view). The pylorus is obliterated. The duodenal bulb is displaced to the left. *(Lower left.)*

Fig. 13-*B* (right lateral view). Stomach is displaced backward. The anterior wall is compressed due to a large liver. *(Lower right.)*

the above case, namely, that forward and upward displacement of the stomach associated with downward displacement of the duodenojejunal flexure could take place only as a result of pressure from outside the stomach and duodenum, and since the pancreas is behind the stomach and above the duodenojejunal junction, a tumor of this organ would produce such an alteration in the position of the stomach. Hence a diagnosis of cancer of the pancreas, with infiltration of the posterior wall of the stomach, was made. This was confirmed by operation.

The above two cases presented no clinical symptoms or physical signs suggestive of cancer of the pancreas. If one were to depend upon the anterior view alone, a diagnosis of tumor of the pancreas would be impossible. By the use of the lateral view and a careful analysis of the relation of the organs a correct diagnosis was the result.

Case 12 (Figs. 12-*A* and 12-*B*). Male, age 45, was recommended for an X-ray examination because of a palpable tumor in the region of the epigastrium which was thought to be a gastric tumor. The anterior view (Fig. 12-*A*) showed obliteration of the pyloric end. The cardiac portion was found to be displaced to the left and the duodenum to the right. The duodenojejunal flexure remained in normal position. In the right lateral view (Fig. 12-*B*) the stomach and duodenum were found to be displaced forward. No abnormal changes were noticed in the contour of the stomach or duodenum. A diagnosis of a retroperitoneal tumor was made. The patient was subjected to a series of X-ray treatments, with complete disappearance of the newgrowth and the return of good health.

Case 13 (Figs. 13-*A* and 13-*B*). Female, age 53, complained of gastric disturbances. An X-ray examination of the gastro-intestinal tract revealed obliteration of the pyloric end, with displacement of the cardiac end of the stomach to the left (Fig. 13-*A*). In the right lateral view the stomach was found to be displaced backward, with the anterior wall of the stomach compressed but with a regular outline. Since the left lobe of the liver is in front of the stomach, an enlargement of the liver would naturally result in such a displacement and compression. The diagnosis of hypertrophy of the liver fully agreed with the clinical and physical signs.

Case 14 (Figs. 14-*A* and 14-*B*). Male, age 31, presented a palpable tumor in the left hypochondrium. The anterior view (Fig. 14-*A*) showed almost complete obliteration of the upper portion of the stomach. In the left lateral view (Fig. 14-*B*) the upper portion of the stomach was found to be displaced backward by a large mass in front of it. The presence of a tumor in the left hypochondrium may originate from one of several organs, namely, spleen, left kidney, pancreas, or liver. In the case of a tumor of the spleen, kidney, or pancreas the stomach would be found to be displaced forward, since they are located behind the stomach. In the case of the liver the opposite would be true, since the left lobe of the liver is in front of the stomach. Hence, a diagnosis of tumor of the left lobe of the liver was made. This was confirmed by operation.

Case 15 (Figs. 15-*A* and 15-*B*). Male, age 63, complained of gastric symptoms. An X-ray examination of the stomach revealed complete obliteration of the pylorus in the anterior view (Fig. 15-*A*). In the right lateral view (Fig. 15-*B*) the stomach and duodenum were found normal in position and shape. A diagnosis of a normal stomach and duodenum was confirmed by operation on the gall bladder.

The above four cases show how often it is difficult to differentiate between deformities of the stomach produced by the neighboring organs and those originating from the stomach proper. By means of the lateral view it is possible not only to exclude

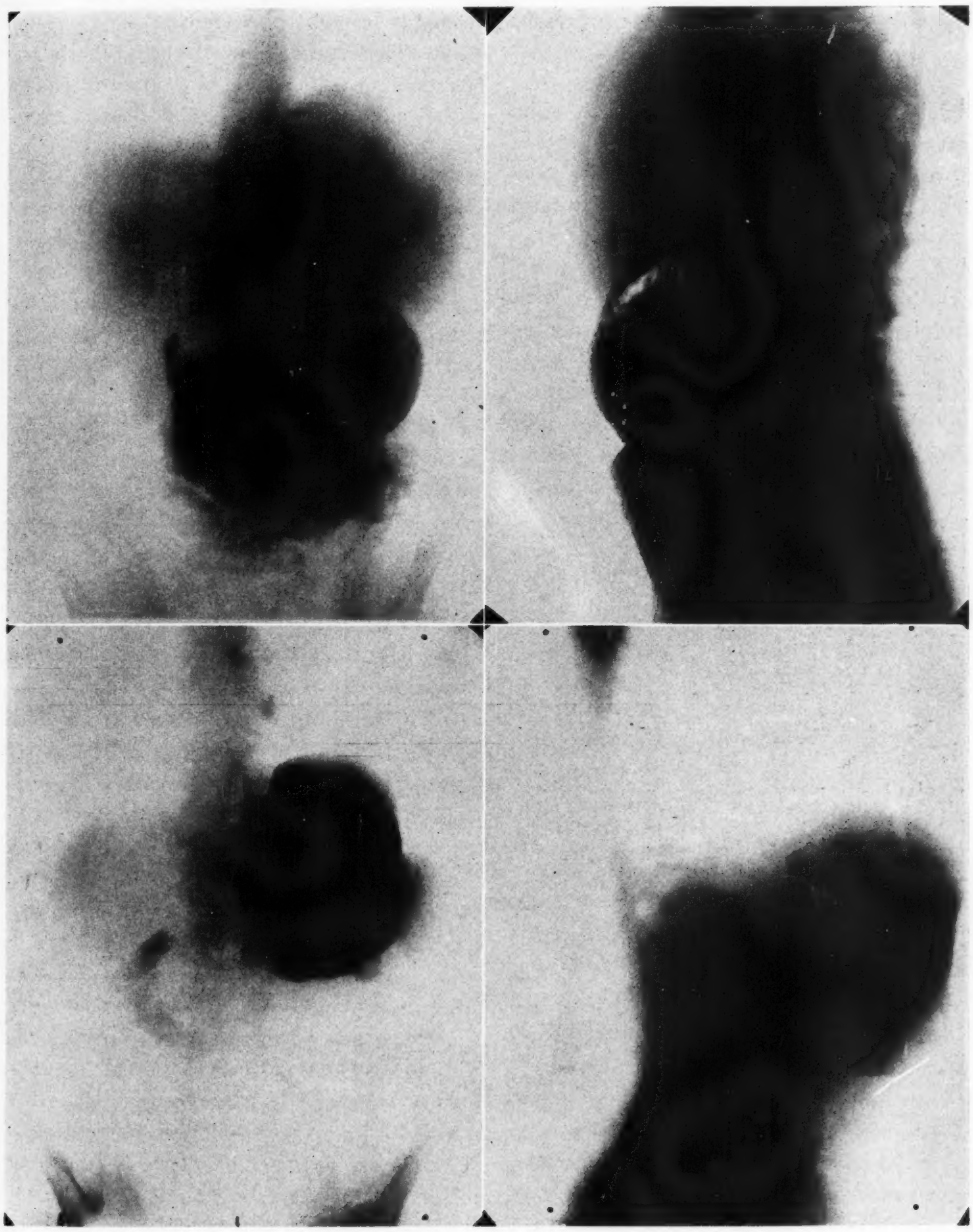

Fig. 14-*A* (anterior view). The upper half of the stomach is obliterated. *(Upper left.)*
Fig. 14-*B* (right lateral view). The upper half of the stomach is displaced backward due to a large tumor of the left lobe of the liver. *(Upper right.)*
Fig. 15-*A* (anterior view). The pyloric end of the stomach is obliterated. *(Lower left.)*
Fig. 15-*B* (right lateral view). The position of the stomach is normal. The duodenum describes a large arc, evidently due to enlarged head of the pancreas. *(Lower right.)*

the stomach, but also to determine the exact organ involved in the pathologic process.

CONCLUSIONS

1. The lateral view of the stomach, either left or right, will often disclose the presence of a deformity in the contour of the stomach which fails to show in the usual anterior or posterior views.

2. The lateral view of the stomach will help to determine the exact origin of a deformity which is recognizable in the anterior or posterior views.

3. The right lateral view of the stomach and duodenum will enable one to visualize the duodenum in its entire course, when it is obscured by the pylorus and any abnormal changes brought into view.

4. The lateral view of the stomach and duodenum will enable one to differentiate between intrinsic and extrinsic lesions affecting the stomach or duodenum, and, if extrinsic, to enable one to determine the exact location and probable nature of the lesion.

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THE STORY OF THE FIRST ROENTGEN EVIDENCE

By SANFORD WITHERS, M.D., DENVER, COLORADO

IT IS my intention to present to you a description of the principals and to some extent the scene in the courtroom where the first X-ray plate was introduced as evidence. Try to visualize my description of a courtroom well filled with prominent people in an action for alleged malpractice in the treatment of a fractured femur against a surgeon of national reputation. This surgeon was, and still is, eminent. He was the first to do an appendectomy in this country; the first to accomplish an anastomosis of the spinal accessory to the facial and descending hypoglossal nerves; a man who has simplified many of our extensive surgical procedures; one of the founders of the American College of Surgeons and the Western Surgical Association, and a member of the Board of Governors of the College of Surgeons.

Defending this suit were a United States Senator, former judges and other attorneys with distinguished records, known throughout this country. The suit was brought April 14, 1896, by one James Smith, a poor boy who was reading law and doing odd jobs to pay his expenses. He was injured in a fall from a ladder while trimming some trees, and after some time he consulted the distinguished surgeon, who made no attempt at immobilization of the thigh but advised exercise of various kinds as though treating a contusion. Prosecuting this suit for James Smith, plaintiff, were Ben B. Lindsey, a young attorney in his early twenty's, and his associate, Fred W. Parks. We have all come to know the name of Ben B. Lindsey as the founder of the Denver Court of Domestic Relations—otherwise known as the Denver Juvenile Court. It is remarkable, too, that Mr. Parks later became the youngest Senator in this State and had a varied and interesting political career.

The docket number of this case is 24,159 in the District Court of Arapahoe County, now the District Court of Denver, Colorado. At that time there was only one higher court in Colorado, the Appellate Court. On the day in question, Thursday, December 2, 1896, there sat upon the bench Judge Owen E. Le Fevre, a man who had made a considerable fortune in mining, who had been a lawyer whom every one trusted, who loved horses, sports, and his fellow-men—Judge Le Fevre, large of build and short in stature, with a very large head and a mass of snow-white hair, a closely clipped white mustache, and exceedingly pink face.

The young attorneys, Lindsey and Parks, qualified one H. H. Buckwalter as an expert in photography and in the use of roentgen rays, for he had been making X-ray shadowgraphs for the past eight months for his own amusement and that of his friends. He, with Dr. C. E. Tennant, of Denver, had become acquainted with Roentgen's work and, after similar experiments, agreed to attempt to take a picture of the hip of James Smith. Plates were made November 7, 11, 21, and 28, 1896. The most satisfactory one required an exposure of eighty minutes (personal communication from Dr. Tennant).

Judge Lindsey says that he had been in personal communication with judges in the East who had refused to accept X-ray plates as evidence, and that one of them had stated to him that he had sustained an objection to offer the X-ray plate in evidence "because," said he, "there is no proof that such a thing is possible. It is like offering the photograph of a ghost," continued the

judge, in his opinion, "when there is no proof that there is any such thing as a ghost."

In order to convey the idea of radiographic shadows to the judge and jury, Buckwalter, Lindsey, and Parks contrived a shadow box by means of a box with a small hole at one end through which illumination came from a lighted candle casting a shadow upon a screen at the opposite end of the box. They first showed the shadow of a hand. This was viewed by the jury and then an X-ray shadowgraph of a hand was shown. X-rays of other objects, such as small wheels of a clock, etc., were shown to the judge and jury. Next a normal femur was shown, its shadow being projected onto the screen by the light of the candle. Then the roentgen shadowgraph of such a femur was shown, and, finally, there was shown the X-ray plate taken of James Smith's left femur in the region of the hip joint. This radiograph showed that the head of the bone was not in normal relation to the great trochanter and shaft, and it was proposed by Lindsey and Parks that this radiograph, "shadow picture," or "roentgen picture," as it was called, be submitted to the jury as evidence that there had been a fracture of the femur in the region of the great trochanter, with impaction of the fragments.

The late United States Senator from Colorado, Charles J. Hughes, who was considered the most brilliant lawyer Denver ever had, argued for the defense for more than three hours against the admission of such evidence, stating that "X-ray photographs" are not admissible under the law, and past decisions of the courts bore this out. He contended, furthermore, that even should it be admitted that this was a photograph of James Smith's femur, it could not be used as competent testimony under the broad principle of the law upon the matter of photographs as testimony, that witnesses must testify to having seen the object which has been photographed and to having identified the photograph as a good likeness of the object—then only may any photograph be admitted as evidence. This argument for the defense had taken the entire afternoon and Judge Le Fevre informed the attorneys that he would rule the following morning on the matter of the several X-ray plates taken November 7, 11, 21, and 28, 1896, purporting to show the deformity of James Smith's femur.

There was a large crowd in the courtroom when Court convened at 9 o'clock the next morning, for the papers had printed the story of how the X-ray equipment and Crookes' tube had been produced in the courtroom and explained to the jury, and that actual X-ray photographs of the bones in the human body had been shown openly in court. This paraphernalia had made a profound impression on the newspaper men who published the whole story prominently in the morning papers.

In telling of this Judge Lindsey states: "The electrical apparatus, batteries, Crookes' tube, etc., were all in the courtroom. We offered to show the jury the bones in their hands, which created such terrific excitement about the courthouse that extra bailiffs were called in to keep the court in order during the argument. The excitement was intense, the 'gallery' all on my side, restrained from breaking into applause on several occasions because of their anxiety to have this 'miracle' demonstrated and actually recognized by a court."

The following is a verbatim copy of Judge Owen Le Fevre's opinion on the exhibits, consisting of four X-ray plates, as handed down (*Denver Republican,* Thursday morning, December 2, 1896):

The defendant's counsel objected to the admission in evidence of exhibits, the same being photographs produced by means of the X-ray process, on the ground that, being photographs

of an object unseen by the human eye, there is no evidence that the photograph accurately portrays and represents the object so photographed. This rule of law is well settled by a long line of authorities and we do not dissent therefrom as applied to photographs which may be seen by the human eye. The reason of this salutary rule is so apparent to the profession that as a rule of evidence we will not discuss it.

We, however, have been presented with a photograph taken by means of a new scientific discovery, the same being acknowledged in the arts and in science. It knocks for admission at the temple of learning; what shall we do or say? Close fast the doors or open wide the portals?

These photographs are offered in evidence to show the present condition of the head and neck of the femur bone, which is entirely hidden from the eye of the surgeon. Nature has surrounded it with tissues for its protection and there it is hidden; it cannot by any possibility be removed nor exposed that it may be compared with its shadow as developed by means of this new scientific process.

In addition to these exhibits in evidence, we have nothing to do or say as to what they purport to represent; that will, without doubt, be explained by eminent surgeons. These exhibits are only pictures or maps to be used in explanation of a present condition, and therefore are secondary evidence, and not primary. They may be shown to the jury as illustrating or making clear the testimony of experts.

The law is the acme of learning throughout all ages. It is the essence of wisdom, reason, and experience. Learned priests have interpreted the law, have classified reasons for certain opinions which, in time, have become precedents, and these ordinarily guide and control especially trial courts. We must not, however, hedge ourselves round about with rule, precept, and precedent until we can advance no farther; our field must ever grow, as trade, the arts, and science seek to enter it.

During the last decade, at least, no science has made such mighty strides forward as surgery. It is eminently a scientific profession, alike interesting to the learned and unlearned. It makes use of all science and learning. It has been of inestimable service to mankind. It must not be said of the law that it is wedded to precedent; that it will not lend a helping hand. Rather, let the courts throw open the door to all well considered scientific discoveries. Modern science has made it possible to look beneath the tissues of the human body, and has aided surgery in telling of the hidden mysteries. We believe it to be our duty in this case to be the first, if you please to so consider it, in admitting in evidence a process known and acknowledged as a determinate science. The exhibits will be admitted in evidence

It is my pleasure to acknowledge the kind offices of Judge Ben B. Lindsey, the Honorable Fred W. Parks, Dr. W. W. Grant, Dr. C. E. Tennant, and Mr. Cornelius Westervelt for the data incorporated in this paper.

DISCUSSION

DR. I. S. TROSTLER (Chicago): Dr. Withers' paper is of great interest because of its historic value. It gives in detailed particulars what is surely the first instance in the United States, if not in the world, wherein roentgenograms were introduced as evidence before a court of justice. This history of our work has been most interesting to me, and, while I knew something of this Colorado case, I did not know the details and am very glad that Dr. Withers gave them to us in manner and form as he has done.

Radiological history is being written every day, but much more of the record of events which transpired thirty or thirty-five years ago should have been written at the time. I have found such records much in demand, having, during the past month, had numerous requests for reprints of a brief historic outline of some interesting events in radiology which I presented before the Section on Radiology at the 1930 meeting of the Illinois State Medical So-

ciety and which was published in the *Illinois Medical Journal* (November, 1930).

In Dr. Francis Williams' monumental work on "The Roentgen Rays in Medicine and Surgery," the first edition of which was published in 1901 (2d edition in 1902, only five months later), these facts were not recorded. This apparently well-informed author said: "There is, I think, no question but that radiographs will eventually be admitted as evidence by the courts, and they can make some doubtful points perfectly clear."

In the December, 1903, issue of the *Brooklyn Medical Journal,* Hon. W. W. Goodrich, Chief Justice of the Appellate Division of the Supreme Court of the State of New York, mentions a summary of the case described by Dr. Withers, which was published in the *Chicago Legal News.*

Probably one of the most celebrated cases in the United States (although not the first) in regard to the admission of roentgenograms as evidence is that of Bruce *vs.* Beall (99 Tenn. 303), which was decided on Sept. 30, 1897. Judge Beard, who wrote the decision for the Supreme Court of Tennessee, said: "In the progress of the trial, one, Dr. Gattman, was introduced as a witness, and he was permitted to submit to the jury an X-ray photograph taken by him, showing the overlapping bones of one of the plaintiff's legs, at a point where it was broken by this fall. This was objected to by the defendant's counsel. This picture was taken by the witness, who was a physician and a surgeon, not only familiar with fractures, but with the new and interesting process by which this particular impression was secured. He testified that this photograph actually represented the condition of the leg at the point of the fracture in question, and, as a fact, that by the aid of X-rays he was enabled to see the broken and overlapping bones with his own eyes, exactly as if, stripped of the skin and tissues, they were uncovered to the sight. We might, if we desired, rest our conclusion on the general character of the exception taken to this testimony, but we prefer to place it on the ground that, verified as was this picture, it was altogether competent for the purpose for which it was offered. New as this process is, experiments made by scientific men, as shown by the record, have demonstrated its power to reveal to the natural eye the entire structure of the human body, and that its various parts can be photographed as its exterior surface has been and now is."

In the early years of roentgenography, there were quite a number of decisions against the admission of roentgenograms as evidence. Some of these were in Massachusetts, New York, Ohio and elsewhere, but soon the light of sense and justice prevailed and roentgenograms were admitted.

April 16, 1920, I presented a paper entitled, "An Important Supreme Court Decision" before the Chicago Medical Society, which was published in the *Illinois Medical Journal* (August, 1920), wherein I discussed a decision by the Illinois Supreme Court relative to a case wherein roentgenograms of a skull were submitted by a dentist who made them. The Court said:

"Some witness must be able to testify that the picture offered in evidence shows accurately what the witness saw when he looked into the body with the fluoroscope *or* he must be able to say that he is skilled in the use of the X-ray machine and in taking and developing X-ray pictures and that he took the picture offered in evidence with the body in a certain position (describing it) with a machine which he knew to be in good working condition and accurate, and that from his experience he was able to say that the picture produced by the machine was an accurate picture of the internal condition of the body." The judgment for the plaintiff in this case (Roscoe Stevens *vs.* The Illinois Central Railroad Co.) was reversed because the dentist did not and could not qualify properly according to the foregoing requirements.

In that paper I said: "Here is a decision from our own Supreme Court, which verifies and backs up what radiologists have been trying for a long time to impress upon those referring X-ray work—that expert radiol-

ogists, and only graduates in medicine who can qualify as such, should make radiographic examinations."

I owe you an apology for reading you a lesson in the course of a discussion of a fine historic paper such as Dr. Withers has presented, but I cannot help making a practical application of what is an extremely interesting and valuable contribution to the literature of radiology.

The Legal Aspects of X-ray. S. W. Donaldson. Jour. Michigan St. Med. Soc., October, 1930, XXIX, 700.

The legal aspects of the X-ray are more or less confined to three main divisions, namely: (1) Liability arising out of the use of the X-ray, either for diagnostic or therapeutic purposes; (2) liability arising out of failure to use the X-ray, and (3) the X-ray films as evidence. The State and Federal rule regarding physicians in general is as follows: "A physician is bound to bestow such reasonable and ordinary care, skill, and diligence as physicians and surgeons in the same neighborhood, in the same general line of practice, ordinarily have and exercise in such cases." "In the case of a specialist, the standard would be ordinarily that possessed by practitioners devoting special attention and study to the same branch in similar localities, having regard to the present state of medical science."

Most malpractice cases fall under the head of negligence, but there are three other sources of liability which must be remembered: *(a)* Cases in which the operator guarantees no harm; *(b)* the fact that the X-ray is inherently dangerous, and *(c)* the danger of electrocution from high tension current.

The insurance companies carrying malpractice insurance now have a clause in their policies stating that they are not liable for suits brought about by damages after the X-ray has been used for therapeutic purposes. In some instances, the presence of an X-ray burn has been satisfactory evidence that negligence did exist, the argument evidently being that no burn will result from proper equipment properly used, but generally this rule of *"res ipsa loquitur"* does not constitute evidence that negligence did exist. Failure to use the X-ray has been the basis of several suits, and the general principles of the practice in the community usually govern in such suits. With regard to radiographs as evidence, the courts have apparently transferred bodily the rules relative to photographs, and the general tendency is to refer to them as secondary evidence. Undoubtedly there has been a great abuse of the X-ray in the court room and incompetent evidence has been allowed, due to the fact that unskilled men have misinterpreted the findings disclosed. Some courts have given the proper ruling in this connection, one stating as follows: "I do not think the doctrine that an ordinary photograph is the best evidence of what it contains, should be applied to the X-ray films. They constitute an exception to the rule concerning ordinary documents and photographs, for the X-ray films are not the best evidence to laymen of what they contain. The opinion of the expert is the best evidence of what they contain—the only evidence."

W. W. Watkins, M.D.

FURTHER STUDIES OF THE X-RAY STANDARD IONIZATION CHAMBER DIAPHRAGM SYSTEM*

By LAURISTON S. TAYLOR and G. SINGER, Bureau of Standards, WASHINGTON, D. C.

Abstract.—Further studies have been made on the effect of the diaphragm system upon the calibration measurements made with the large free air ionization chamber. Air absorption coefficients were obtained, and it was found necessary to use these values to correct the ionization chamber readings. Calibrations of a thimble chamber, made with and without a restricting diaphragm close to the X-ray tube, differ by several per cent. Dependent upon the position of the thimble chamber with respect to the tube target, the calibration may vary over a range of 10 per cent. When the radiation is not restricted by a diaphragm close to the tube, there may be a difference in the radiation quality received by the thimble and air chamber, as large as 10 per cent.

I. INTRODUCTION

SINCE the completion of some previous studies at the Bureau, of the experimental technic necessary to obtain what was believed to be a correct determination of the recently adopted unit of X-ray quantity, several features of our own work and also that of other investigators seemed to demand further study. Certain pronounced differences appear in the results obtained by various workers, but this is perhaps to be expected, for a careful analysis of the free air ionization chamber systems used by them leaves doubt as to whether or not the several systems should yield accordant measurements of the roentgen.

Failla's[1] thorough experimental study of the diaphragm system was carried out in a manner sufficiently different from ours to render it difficult to decide how well the respective conclusions agree. Ours[2] had a limiting diaphragm close to the X-ray tube and of such size as to cut off all stem and off-focus radiation, whereas Failla omitted this and, instead, placed a somewhat larger diaphragm about 30 cm. from the target, which, therefore, cut off only the extreme stem radiation.[3] Again, Failla, simulating conditions used in practice, apparently obtained a satisfactory determination of the roentgen with a system employing a single diaphragm but a different value with two diaphragms. We, however, were unable to obtain consistent results with a single diaphragm system.

Glasser, since the publication of his report on the X-ray standard ionization chamber,[4] informs us that he has removed the diaphragm close to the tube and finds his unit of quantity unchanged thereby, thus differing in his findings from both Failla and us. Behnken,[5] using a Metalix line focus tube of the 220 K.V. type, which does not demand a tube diaphragm, naturally employs a single diaphragm system.

In the present study, the effects of these different experimental conditions applied to our own system have been investigated. In addition, other geometrical arrangements of various free air ionization chamber systems have been studied.

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*Reprinted from *Bureau of Standards Journal of Research*, 1931, VI, 219.

[1]G. Failla, Am. Jour. Roentgenol. and Rad. Ther., 1929, XXI, 47.

[2]L. S. Taylor, Bureau of Standards Jour. Research (R. P. 119), 1929, III, 807: RADIOLOGY, July, 1930, XV, 49.

[3]In this paper the term "stem radiation" includes that from the back of the target as well as the stem, unless stated otherwise.

[4]Otto Glasser and U. V. Portmann, Am. Jour. Roentgenol. and Rad. Ther., 1928, XIX, 564.

[5]H. Behnken and R. Jaeger, Strahlentherapie, 1930, XXXVI, 778.

II. EFFECT OF POSITION OF CHAMBER DIAPHRAGM WITH RESPECT TO THE COLLECTOR ELECTRODE—AIR ABSORPTION

From a previous analysis by Taylor of the ionization chamber diaphragm system,[6] the effective ionization E, in the chamber, is given by

$$E = \frac{\varkappa b^2 I_0}{B^2} L_0 \qquad (1)$$

where I_0 is the X-ray flux density at unit distance from the focus; L_0 the effective length of the measuring electrode; B the distance between the tube diaphragm and the entrant diaphragm; b the radius of the chamber diaphragm, and $\varkappa$ a constant. This condition holds only when the aperture of the diaphragm system is filled, and absorption and scattering in the intervening air space is negligible.

When using a small focal-spot tube, the focus may be considered a point (within certain ranges) so that B in the relation above is replaced by $B + k$ where k is the distance from focus to tube diaphragm.

Under these conditions the distance between the chamber diaphragm and collector plate should not enter.[7] Consequently, we are led to expect that for a given beam of radiation the ionization currents to the collector electrode should remain constant, as this distance alone is varied, subject, of course, to the one assumption that the radiation be sufficiently penetrating to permit the loss by air absorption between tube diaphragm and collector electrode to be neglected. Failla[8] did find, however, a decrease of some 5 per cent in the ionization currents as the distance from his chamber diaphragm to collector plate was increased from 40 to 110 centimeters.

He attributed most of this 5 per cent change to scattering from the lead walls of the tube which supported the diaphragms although later work on his and our part indicates that the effect was probably largely due to air absorption.[9]

A rough test of this effect, made at the time our free air ionization chamber was designed,[10] showed a negligible change in the ionization current when the distance between chamber diaphragm and collector plate was kept within a working range suitable to our apparatus of from 30 to 45 centimeters. Where the collector to chamber diaphragm distance runs to magnitudes much above this, as in Failla's experimental case, the consequent air absorption should be taken into account as shown below. To

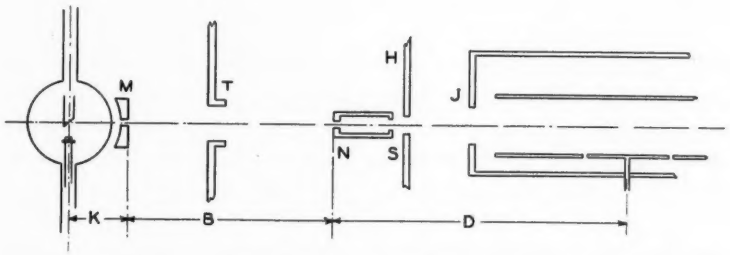

Fig. 1. Diagram of arrangement of ionization chamber and diaphragms used in studying air absorption.

[6] L. S. Taylor, Bureau of Standards Jour. Research (R. P. 119), 1929, III, 807: RADIOLOGY, July, 1930, XV, 49.

[7] This conclusion is in agreement with Behnken's earlier analysis (H. Behnken, Strahlentherapie, 1927, XXVI, 79), but in discord with the work of Kaye and Binks (G. W. C. Kaye and W. Binks, Brit. Jour. Radiol., 1929, II, 553).

[8] See p. 61, Failla's paper, referred to in Footnote 1, p. 104.

[9] Dr. Failla has very kindly made certain of his unpublished data available to the authors. It is very gratifying to find that his measurements check ours as to the effect of air absorption.

[10] L. S. Taylor, Bureau of Standards Jour. Research (R. P. 56), 1929, II, 771: RADIOLOGY, April, 1930, XIV, 372.

TABLE I

No.	Tube	K.V.	Filter	Distance B	$I_{max.}$ $D = 41.7$	$I_{min.}$ $D = 101.7$	Difference	Average deviation from mean	μ cm.$^{-1}$ $\times 10^{-5}$
		1	2	3	4	5	6	7	8
			mm. Cu				Per cent	Per cent	
1	A	140	0.00	62.2	73.1	68.8	6.00	0.26	99*
2	A	140	.25	62.2	38.8	38.0	2.08	.51	35
3	A	140	1.00	62.2	19.55	19.17	1.96	.31	33
4	B	133	.00	40.5	63.69	60.55	3.40	.28	84*
5	B	133	.10	40.5	63.41	61.62	2.86	.30	46
6	B	133	.25	40.5	75.03	73.03	2.33	.46	44
7	B	133	1.00	40.5	26.11	25.69	1.65	.36	27
8	B	112	.25	40.5	42.37	41.26	2.63		45

Note: See explanation of asterisk (*) in Column 8, on page 107.

test the effect of air absorption more carefully, it was decided to repeat these measurements over a wider range of distances between chamber diaphragm and collector, and, in addition, for several radiation qualities.

For this purpose the ionization chamber diaphragm, consisting of both the limiting (N) and the scattering (S) diaphragm, was removed from the chamber and supported rigidly in the center of the beam as indicated in Figure 1. The size of the diaphragm N and its distance from the tube diaphragm M were so adjusted that the diameter of the beam was small. The opening J in the front of the chamber was about 8 cm. in diameter, while the maximum diameter of the beam was about 3 cm., so that, proper alignment having been assured, no part of the beam was cut off. These features were each checked by means of a fluorescent screen. Finally a lead screen H was placed so as to prevent scattered radiation, from any preceding parts of the system, entering the chamber.

Maintaining B constant, the ionization chamber was moved along a track, in the direction of the beam, through a variable range from $D = 41.7$ cm. up. All other factors remaining constant, the resulting ionization currents in the chamber were measured by a null method,[11] precautions being taken to insure that the X-ray beam did not pass so near to the electrode as to exclude utilizing the full range of the photoelectrons.

Figure 2 shows the plot of a typical set of such measurements, from which it is seen that the intensity of the beam falls off several per cent as the distance D is increased. It is also seen that as the radiation is hardened by increasing the filtration, the absorption per unit distance becomes less.

Table I gives the results of several sets of such measurements. Columns 4 and 5 indicate, respectively, the maximum and minimum ionization currents obtained at $D = 41.7$ cm. and $D = 101.7$ cm., represented by (a) and (b) in Figure 2. The percentage change in the measured ionization current appears in Column 6 and the average deviation from the mean of the observations for a single run, in Column 7.

The change in ionization current with increasing D, which is relatively large for unfiltered radiation and only one-third as much for filtered radiation, indicates that the assumption of no loss by absorption along the path certainly does not appear justified.

From these measurements it is possible to calculate by means of the usual absorption

[11] See Footnote 10, on page 105.

formula, $I = I_o e^{-\mu x}$, fairly accurate values of the air absorption coefficients for the various qualities of radiation used. For the thickness x of the absorbing medium (air) we may use the difference between the two values of D at which the intensity

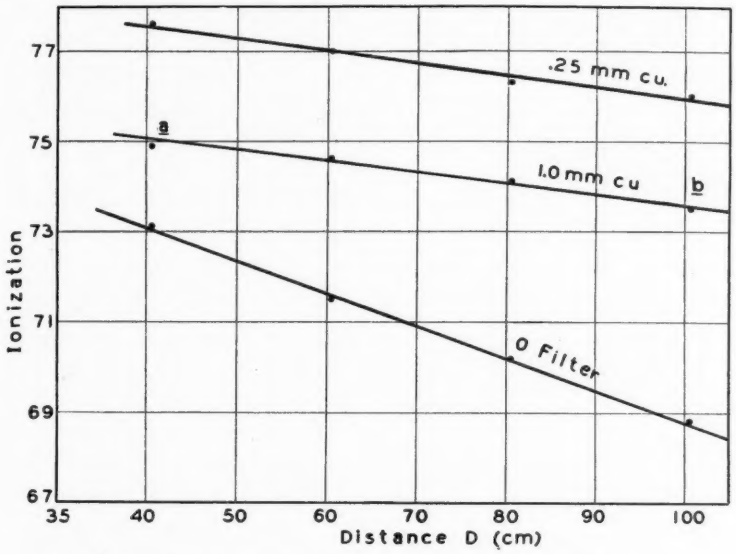

Fig. 2. Intensity of ionization as a function of the distance D.

measurements in Table I were made. The initial intensity I is taken as that for $D =$ 41.7 cm. and the transmitted intensity through 60 cm. of air as that for D = 101.7 centimeters. Substitution of these values of I and I_o in the equation gives, for each radiation quality, the absorption coefficients shown in Column 8.

It should be pointed out that for a very accurate determination of air absorption coefficients, it is undesirable to use such a great thickness of the absorbing medium, since there will be a slight change in the radiation quality due to absorption between the two positions of the ionization chamber used. This is, of course, more important for unfiltered radiation, and, consequently, the values of μ marked with an asterisk (*) in Table I should not be given as much weight as the other values. In the case of filtered radiation, this error may be neglected as indicated by the fact that as the filtration of 140 K.V. radiation is increased from 0.25 mm. to 1.0 mm. of copper, the absorption coefficient decreases from 0.00035 to 0.00033 cm.$^{-1}$ only.

As known, the total absorption coefficient, μ, consists of two parts, σ and τ, such that[12]

$$\mu = \sigma + \tau$$

where τ is the true absorption coefficient and σ is the scattering absorption coefficient. If, now, σ is appreciable, the effective ionization per cubic centimeter in the ionization chamber should be perceptibly decreased by enlarging the cross-section of the beam in the chamber, either by changing the opening in the entrant diaphragm or by changing the distance D in either case, the intensity being kept constant. In an earlier contribution, using the same set-up, no such change was found by the authors,[13] hence we may assume that σ plays no appreciable part here in decreasing the ionization observed.

In seeking to compare these results with

[12]See A. H. Compton, "X-rays and Electrons," p. 175.
[13]See Footnote 2, on page 104.

TABLE II

K.V.	Filter	r/min.	r/full scale M in	r/full scale M out	Difference = $\frac{M \text{ in} - M \text{ out}}{M \text{ out}}$
1	2	3	4	5	6
	mm. Al				Per cent
103	5	1.65 1.76	3.02	2.99	+ 1.03
102	3	1.54 1.79	3.17	3.04	+ 4.27
85	0	9.35 11.93	3.18	3.10	+ 2.58
108	5	1.56 1.63	2.98	2.90	+ 2.76

previous work we find that reliable air absorption coefficients are not available. However, the use of a value of μ for air given by Eve and Day[14] as 0.0004 cm.$^{-1}$ for roughly the same radiation quality corresponding to 112 K.V. radiation filtered with 0.25 mm. of copper, results in a decrease in intensity of about 2.4 per cent per 60 cm. as against 2.63 per cent found in our experiments. Considering the uncertainties in the earlier work this may be taken as fair agreement.

Having found that air absorption can not be neglected we should note the effect of this on the measurements made with large free air ionization chambers. In the chambers used by several observers the distance between chamber diaphragm and the collector plate varies from about 30 to 50 centimeters. Thus, if comparing two such chambers in which this difference is appreciably different, full allowance should be made for the air absorption of each quality of radiation employed in the comparison.

When calibrating a thimble chamber against a free air chamber, the former is usually placed at the position of the free air chamber diaphragm. Consequently the radiation, being partially absorbed within the large chamber, is more intense at the position of the small chamber than indicated by the measurements made with the large chamber. This may be corrected, by allowing for the air absorption in the air path between the chamber diaphragm and collector.

In the guarded field ionization chamber, recently described by the authors,[15] the distance between entrant diaphragm and collector is about 10 cm., consequently the error due to air absorption is reduced to about 0.4 per cent for filtered radiation. For the most precise work, however, this effect should be taken into account.

III. EFFECT OF DIAPHRAGM FOR LIMITING FOCAL RADIATION

The effect of omitting the diaphragm M placed next to the tube to eliminate stem and off-focus radiation was studied. Results were obtained most conveniently by comparing the ionization currents in two different chambers, both with and without the diaphragm in place.[16]

The method of observation was, first, with the diaphragm M in place, to measure the intensity of the beam, with the large air ionization chamber and then with a thimble chamber placed at the position of the chamber entrant diaphragm; and, second, with the diaphragm M removed, to repeat these measurements. In the first case the stem radiation is cut off; under the second set of conditions, to simulate practice, the beam is limited by the diaphragm T having a diameter of about 4 cm., so that a portion of the stem radiation falls on the thimble chamber or entrant diaphragm of the standard chamber, both at 90 cm. from the target.

Table II gives the results of a series of such measurements which happened to be made at lower voltages. Similar runs for higher voltages gave essentially the same results. Column 3 gives the roentgens per

[14] A. S. Eve and F. H. Day, Phil. Mag., 1912, XXIII, 683.

[15] L. S. Taylor and G. Singer, Bureau of Standards Jour. Research (R. P. 211), 1930, V, 507: RADIOLOGY, December, 1930, XV, 637.

[16] Obviously the magnitude of the difference between the ionization currents will depend in a large measure upon the particular choice of the chambers, and consequently such results have no quantitative value other than indicating the magnitude and direction of error.

minute as measured by the air chamber. Columns 4 and 5 indicate, respectively, the number of roentgens per full scale for the thimble chamber electroscope, with M in and out. Column 6 gives the percentage difference between the calibrations of the thimble chamber in the two cases.

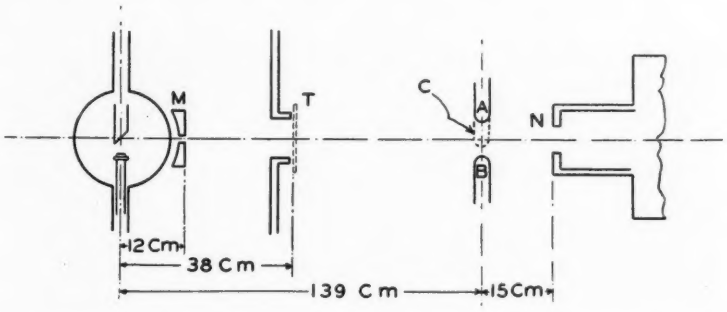

Fig. 3. Diagram showing arrangement of thimble chambers for calibration.

It is seen that, as might be expected when the tube diaphragm M is omitted, the thimble chamber indications are in all cases larger than those of the air chamber, due to the fact that the former receives X-rays from a greater portion of the radiating source. Thus for calibration purposes it is obviously necessary that both chambers receive radiation from the same parts of the target.

The magnitude of such a variation depends upon the size and shape of the thimble chamber used and upon its distance from the target or diaphragm T. Since thimble chambers all vary in construction, it is obviously unsafe to rely upon a calibration effected by a system which does not strictly limit the beam to focal radiation.

IV. POSITION OF THIMBLE CHAMBER FOR CALIBRATION

As pointed out in a previous paper by the authors, different observers employ different methods of calibrating a thimble chamber against a standard.[17] It was further shown that the replacement method was the most reliable. In view of the results of Section III, it was of interest to compare the three more common methods with the additional variable factor of changing the diaphragm M.

[17] L. S. Taylor and G. Singer, Bureau of Standards Jour. Research (R. P. 169), 1930, IV, 631: Radiology, August, 1930, XV, 227.

TABLE III

No.	Position	K.V.	Filter	r/min. M in	r/min. M out	r/full scale M in	r/full scale M out	Difference $\frac{M \text{ in}-M \text{ out}}{M \text{ out}}$	Error of observation
1	2	3	4	5	6	7	8	9	10
								Per cent	Per cent
1	A	140	0.25	1.396	1.418	1.412	1.501	−5.9	0.23
2	A	140	.10	2.354	2.528	1.509	1.619	−6.8	.27
3	B	140	.25	1.420	1.490	1.310	1.285	+1.9	.82
4	B	140	.10	2.330	2.410	1.386	1.363	+1.7	.48
5	C	140	.25	2.506	2.668	1.429	1.413	+1.2	.58
6	C	140	.10	3.205	3.352	1.357	1.343	+1.5	.59

TABLE IV

	A' (stem—O. F.)				*B* (F. + stem + O. F.)				
Filter	*I*	I_2/I_1	μ	λ_e	*I*	I_2/I_1	μ	λ_e	$\Delta\lambda_e$
1	2	3	4	5	6	7	8	9	10
			cm.$^{-1}$	Å.			cm.$^{-1}$	Å.	Per cent
0.10	57.00				57.90				
.15	43.00	0.754	56.4	0.338	45.20	0.780	49.8	0.322	4.85
.20	35.30	.821	39.4	.296	38.70	.856	31.0	.272	8.45
.25	30.20	.856	31.0	.272	34.00	.878	26.0	.255	6.44
	A (Stem + O. F.)				C (Focal)				
0.10	62.97				80.37				
.15	45.34	0.720	65.8	0.357	62.25	0.776	50.6	0.324	6.76
.20	36.26	.801	44.4	.310	52.90	.847	33.4	.280	10.16
.25	30.50	.841	34.6	.282	46.20	.873	27.2	.259	8.49
.30	26.40	.866	28.8	.265	42.00	.908	19.8	.230	14.10
.35	23.31	.882	25.6	.253	38.23	.910	18.8	.225	11.70
.40	20.86	.894	22.4	.241	34.96	.913	18.2	.222	8.19
.45	18.46	.884	22.6	.242	31.94	.914	18.0	.221	9.09

The experimental arrangement is indicated in Figure 3. A paraffin thimble chamber about 3 cm. long was placed successively in three positions: *(a)* to one side of the beam in the direction of the tube anode, *(b)* to the cathode side of the beam, and *(c)* in beam center, and for each position was calibrated in Section III against the large air chamber system with and without the diaphragm *M* in place. The thimble chamber and air chamber were placed 139 cm. from the target for Position *c*, but the air chamber was placed 154 cm. away for Positions *a* and *b*. In each case the alignment was tested with a fluorescent screen.

Columns 5 and 6 in Table III give the beam intensity in roentgens per minute as measured with the large air chamber with diaphragm *M* in and out, respectively. Columns 7 and 8 give the corresponding roentgens per full scale as measured with the thimble chamber. (The electroscope used in these measurements differed from that used in Section III and had greater sensitivity.) Column 9 indicates the percentage change in the ionization measured with the thimble chamber when the diaphragm *M* is removed. Rows 3 to 6 are seen to be in good agreement in this respect with the results given in Table II and further indicate that there is no essential difference in the calibration effected at positions in the center and at the cathode side of the X-ray beam. For both Positions *B* and *C*, the omission of the diaphragm *M* raises the thimble chamber measurements about 2 per cent, throwing the calibration in error by that amount.

However, Rows 1 and 2 for the thimble chamber in the anode side of the beam show that there is a very large decrease in the relative ionization measured when *M* is removed. The geometry of the system makes the reason clear; the diaphragm *T* shields the thimble chamber from a considerable portion of the stem radiation which is allowed to enter the large air chamber. We are thus led to the conclusion that, even without the diaphragm *M*, the most satisfactory position for the calibration of a thimble chamber is in the beam center, thus necessitating a replacement method of measurement.

V. VARIATION OF RADIATION QUALITY FROM DIFFERENT PARTS OF TARGET AND STEM

E. Lorenz[18] found that the continuous spectrum radiation, produced by electrons striking the back of the target and stem after reflection from the target face, had a definite short wave length limit depending upon the position along the anode at which it was produced. This leads at once to the conclusion that the quality of the radiation from various parts of the anode other than the focal spot should vary over wide limits. Since the ionization measured by most small chambers depends upon the radiation quality, it is important to know to what extent such a variation in quality exists.

To determine the magnitude of such quality change, three sets of conditions were chosen by shielding off certain parts of the radiation: *(a)* A thick lead wedge was so placed as to prevent all focal radiation from entering the air ionization chamber; *(b)* the wedge was removed, thus allowing the total radiation from focus, target back, and stem to enter the chamber; *(c)* the diaphragm *M* (Fig. 3) was placed in the beam and adjusted to such a size that only focal radia-

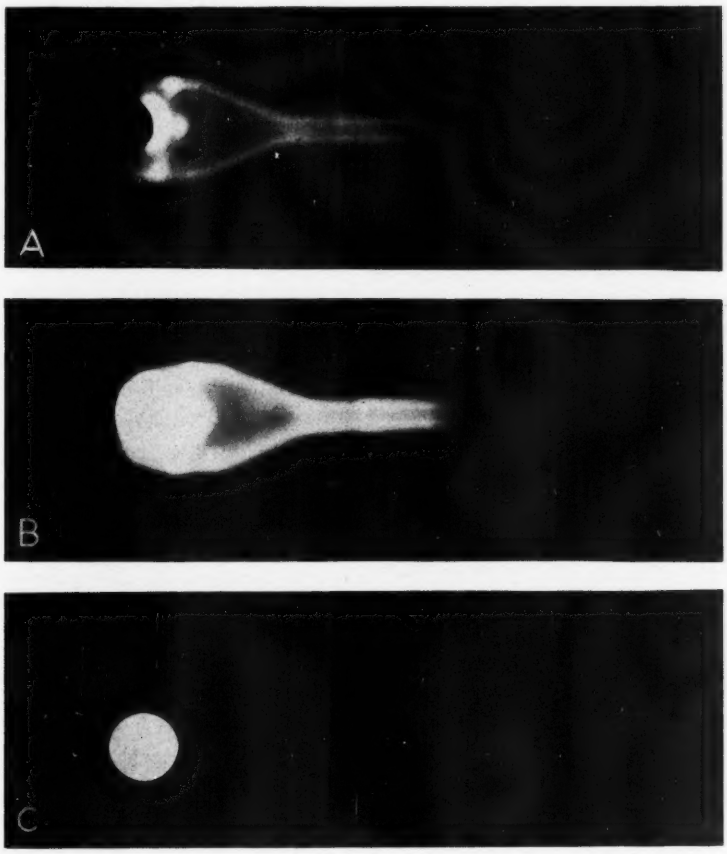

Fig. 4. Pinhole photographs of target (pinhole at position of diaphragm *T* in Figure 1). *(A)* Wedge placed to cut off focal radiation; *(B)* total radiation from anode; *(C)* focal radiation only, as limited by diaphragm *M*.

[18] E. Lorenz, Proc. Nat. Acad. Sci., 1928, XIV, 582.

tion entered the chamber. Figure 4 shows pinhole photographs of the target for each of the three conditions. Under each set of conditions the effective wave length was determined by the finite filter method,[19] using a copper filter 0.05 mm. thick. (Since all effective wave lengths were measured by the same method there is no necessity for comparative purposes of reducing them to true effective wave lengths.)

The results of such quality measurements made with two X-ray tubes are shown in Table IV. A voltage of 130 K.V. ripple potential,[20] having very small ripplage, was applied to the tube. Intensity measurements *I* were made with the free air ionization chamber for the different filtrations indicated in Column 1. The transmissions of 0.05 mm. copper for increasing initial filtration of copper are given in Columns 3 and 7. In Columns 4 and 8, and 5 and 9, are given the corresponding copper absorption coefficients and effective wave lengths.

Comparing the quality of the focal *(C)* and stem radiation *(A)* for the same filtration we find a marked variation between the effective wave lengths λ_e over the whole range studied. Column 10 gives the percentage difference in λ_e for the two beams. Likewise there is a large difference in quality between the stem *(A')* and the total radiation *(B)*. (Data *A'* and *B* were for a fine focus tube, while *A* and *C* were for a broad focus tube of the same type, so that the two are not directly comparable.) However, it is seen that the change in λ_e for total *(B)* and stem *(A')* radiation is intermediate between zero change and that found for focal *(C)* and stem *(A)* radiation. This is to be expected, for in data *B* we have simply an addition of a radiation of different quality to that corresponding to data *A'*.

Furthermore the distribution of scattered electrons over the back of the target and stem will vary both with filament current and tube potential; and, as a result, there will be a variable quality for the stem radiation dependent upon these factors. In general, this will affect seriously the calibration of a thimble chamber.

These results again emphasize the importance of limiting the standard X-ray beam to the focal radiation for which the quality is uniform unless all chambers receive radiation from exactly the same portions of the anode—an obviously impractical restriction.

It has been argued that, for purposes of medical application, the thimble ionization chamber should be calibrated under the same conditions as it will be subject to when used in practice; that is, exposed to the total radiation from the anode. This and previous studies by the authors show that such a method is impracticable if we are to measure X-ray intensity in terms of the international roentgen. Moreover, no errors will be introduced if the chamber is calibrated under experimentally ideal conditions and used in practice under very different conditions, provided care is taken to use the proper radiation quality. If a correct calibration is in roentgens under well-defined conditions, the thimble chamber will always indicate roentgens for beams of the same quality under which the calibration has been effected. For example, if a calibration be made for a quality λ_e where all the radiation comes from the focus, the chamber will indicate correctly for the same radiation quality λ_e, regardless of whether the source includes the stem as well as the focus. The effects of variations in the radiation quality due to the source are taken care of by the very nature of the primary calibration of a thimble chamber.

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[19] L. S. Taylor, Bureau of Standards Jour. Research (R. P. 212), 1930, V, 517: RADIOLOGY, March, 1931, XVI, 302.

[20] L. S. Taylor, Bureau of Standards Jour. Research (R. P. 217), 1930, V, 609: RADIOLOGY, June, 1931, XVI, 893.

INTRAVENOUS PYELOGRAPHY IN RENAL TUBERCULOSIS

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RENAL tuberculosis may be acute or chronic—part of a generalized tuberculosis or more or less localized in the kidney. If part of a generalized tuberculosis, the tuberculous process in the kidney consists of tubercles (few or many) in one or both kidneys, the result of a metastatic hematogenous infection. The tubercles implanted in the glomeruli cause invasion into the tubules, and, secondarily, the pelvis of the kidney, ureter, and bladder become involved in a descending tuberculous pyelonephritis.

Chronic local caseating cavernous tuberculous pyelonephritis may also result from an *ascending* tuberculosis from the bladder or prostate.

Primary renal tuberculosis is extremely rare—practically all cases are secondary to pulmonary or intestinal involvement.

In a well established case the renal pelvis may be shrunken but is usually dilated and the ureter is frequently found at autopsy to be as large as a man's thumb.

The symptoms of renal tuberculosis are insidious in their onset and not referable to the kidney until the disease is well advanced, but there may be a dull aching pain in the region of the kidney, lasting from one to three years, and accompanied by slight to moderate tenderness on pressure.

There are none of the usual symptoms of renal inflammation such as colic, with pain referred down along the ureter, unless the ureter becomes blocked, which usually does not take place until late in the disease. Chills, fever, sweats, emaciation are, of course, late symptoms. "Almost without exception, patients suffering with renal tuberculosis present themselves for relief from frequent and painful urination" (1).

Pyuria is always present, hematuria is less frequent, and the urine is usually strongly acid and of low specific gravity. Tubercle bacilli are found in the urine, either microscopically or by guinea pig inoculation, in 85 per cent of the cases, but this does not tell which kidney is involved. This can be done only by separating the urine from the two kidneys by ureteral catheterization.

"The bladder, even though the mucosa is not markedly involved, is extremely intolerant of any foreign medium introduced and therefore a general anesthetic is necessary for a complete cystoscopic examination" (Pilcher, 1). As stated above, renal tuberculosis is almost always secondary to pulmonary or intestinal involvement, and, in pulmonary tuberculosis especially, a general anesthetic is dangerous.

Ureteral catheterization may be necessary to the making of an accurate diagnosis, but the general anesthetic should be avoided.

Ascending pyelography is also a procedure that should be avoided, if possible. Kearns (2) reserves the ascending pyelogram for those cases in which the diagnosis is doubtful and refrains from injecting kidneys with advanced cavernous disease because of danger of rupture into the kidney substance. This contention is supported by O'Conor, Cabot, and Eberbach (3), and this opinion is also supported by most European urologists, who believe the dangers and disadvantages of ascending pyelography outweigh the advantages. Aside from the danger of dissemination, it is also unwise to subject these patients, who are especially upset by instrumentation, to the unnecessary shock. Any other method that will visualize the urinary tract and at the

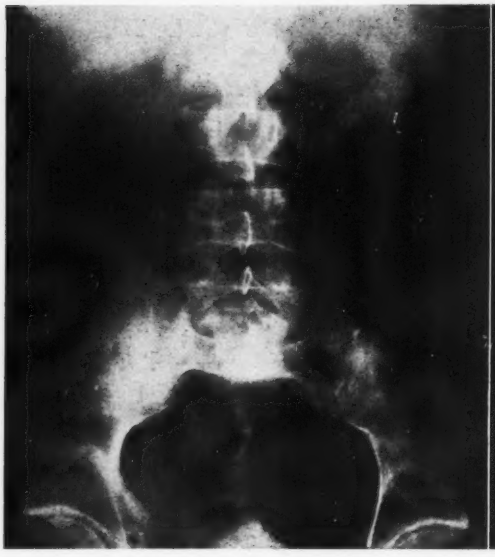

Fig. 1. Case 2. Film taken 35 minutes after injection.

Fig. 2. Case 2. Film taken 90 minutes after injection.

same time obviate the necessity of a general anesthetic, the shock of instrumentation, and dangers of dissemination of the disease is indeed welcomed by urologists and those dealing with tuberculosis in general.

Intravenous pyelography affords such a method and it has been our good fortune to use it in five cases of renal tuberculosis. In all but one of these cases, the renal involvement was accompanied by more or less advanced pulmonary tuberculosis, with symptoms of active disease. In two of these cases, ascending pyelography had been attempted elsewhere without success and with decidedly harmful effects on the patients.

In reporting these five cases, it is not our purpose to draw any general conclusions (the number of cases is too small for that), but to demonstrate that the method is of value in visualizing the tuberculous kidney, ureter, and bladder and that it will at least show gross pathologic deformities in both kidneys and ureters. Some knowledge of the relative excretory power of the two kidneys can also be gained and a more satisfactory knowledge of the extent of the lesions may be obtained. The method is simple, direct, and painless and in these five cases at least it has been absolutely harmless. There has not even been a transient increase in pulse or temperature in any of them. The only symptoms of reaction have been a sense of warmth and flushing a few minutes after the intravenous injection was started, pain in the arm on the side being injected in two cases, and a sensation of pain and fullness over the kidneys which lasted about an hour and a half in one case.

The substance used to visualize the urinary tract is known by the trade name of uroselectan and is indirectly the result of the successful research to obtain a contrast substance for visualizing the gall bladder by the X-ray.

Iodeikon, because of its high iodine content and excretion through the bile, makes the visualization of the gall bladder possible. Binz and Räth introduced another iodine compound—selectan neutral—that was excreted in large quantities through the urine,

and Swick, of New York, working in the clinic of Lichtwitz (Hamburg) clearly demonstrated that the urinary system could be visualized with this substance. The drug, however, caused nausea and headache, and a modification of the preparation was made which reduced the toxicity to such an extent that larger quantities could be tolerated and a higher concentration in the urine obtained. This preparation is now in use under the name uroselectan. It is non-toxic, easily soluble in water, contains 42 per cent iodine, and is excreted by the kidneys in sufficient concentration to give a good roentgenographic contrast with the ordinary and usual technic. It is apparently excreted through the kidneys unchanged in form—iodism has never been observed; therefore, it is harmless in tuberculosis.

The following directions are taken from Hirsch's (4) recent article in RADIOLOGY:

The technic of intravenous urography is extremely simple. The drug uroselectan is a powder put up commercially in forty-gram packages. The forty grams are completely dissolved by gradually adding them to 80 c.c. of previously heated, double distilled water. The volume is then made up to 110 cubic centimeters. It is filtered twice and then sterilized by heating it over a steam bath for twenty minutes. The solution, cooled to body temperature, should have a volume of 110 cubic centimeters. For obese patients, 60 grams are necessary. Three packages are then dissolved in 220 c.c. of water and 110 c.c. of the solution is used for a case. When cooled, the 110 c.c. is injected intravenously in two parts, with a syringe,[1] allowing a brief interval between injections. The injection is made in the X-ray department by a member of the department's staff. The simple procedure of the injection needs no elaboration. The patient has a sensation of warmth, particularly over the face and vesical regions. The subjective sensations are not at all uncomfortable—it is only to avoid any possible discomfort that the solution is injected in two parts. There is, however, no objection to injecting the entire 110 c.c. at one time. There are no after-effects whatever. After the radiographs have been made, the patient may resume his usual routine. The methods of oral and rectal administration give results inferior to those which may be obtained when the drug is administered intravenously.

Fig. 3. Case 2. Film taken 120 minutes after injection.

The preparation of the patient is the same as for the usual roentgen examination of the urinary tract. The bladder is emptied and a preliminary roentgen examination is made before the uroselectan is injected.

Though the concentration of uroselectan in the urine varies, it is usually about 5 per cent. The roentgenograms, even in normal cases, have not, therefore, the photographic contrast obtainable with solutions in use for instrumental pyelography. In cases in which there is kidney damage, this contrast is still further diminished. A slight modification of the X-ray technic may, therefore, be necessary for good contrast.

The technic includes the customary immobilization, the use of the grid, and the usual urinary tract "set-up." The routine 14 × 17

[1]The writers have found it more convenient to give the intravenous injection by the gravity method in one part, taking fifteen to twenty minutes to give the injection.

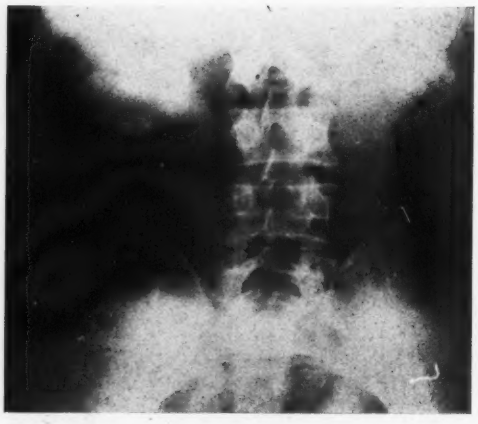

Fig. 4. Case 3. Film taken 75 minutes after injection.

film should be supplemented by separate films of either or both kidneys, and the lower portion of the tract. Compression with the inflated bag or loofah sponge may be applied a short time before the exposures are made, though this is by no means essential. The roentgen study is a serial one.

The first urogram may be made fifteen to twenty minutes after the injection and a second exposure fifteen to twenty minutes later. The patient should be permitted to void after the second exposure. The withholding of urination over a long period is not necessary. Overdistention of the bladder hides the lower portion of the ureters. Three subsequent urograms may be made at intervals of fifteen to twenty minutes, making a total of five in all. If the visualization of the entire urinary tract on both sides is clear and definite in the first or in the second film, this may be considered sufficient, and the examination may be called complete. If, however, there is no visualization at first, it is necessary to make the entire set of five films.

In cases in which there is considerable renal dysfunction, clear visualization may not be obtainable until from six to twenty-four hours have elapsed.

It would appear that in actual practical work, three exposures, the first at fifteen, the second at forty-five, and the third at seventy-five minutes after the injection, will suffice.

The period of maximum visualization may be determined by fluoroscopic examination. Within five minutes after the injection the contrast substance may be visualized in the kidney, but the tract in its entirety cannot be visualized before twenty minutes have elapsed (4).

The more normal the renal function the greater the concentration, the more rapid the elimination, and the more clear the X-ray visualization. Therefore, the time of excretion and X-ray delineation constitutes a rough method of estimating the renal function on each side. Depending on the degree of renal destruction, there is poor or delayed or no visualization whatever. In our cases, even though marked deformity of the renal pelvis might be noted, the function in most instances was good. The ability of the tuberculous kidney to do its work in spite of severe anatomical changes is apparently remarkable.

CASE REPORTS

The following case histories, with their accompanying roentgenograms, are included to illustrate the method.

Case 1. J. F. H., male, 26 years of age, had predominant symptoms as follows: severe lumbar pain, nausea, cough, expectoration, elevation of temperature, and severe chills about every ten days to two weeks. Tubercle bacilli present in urine. Ascending pyelography unsuccessful.

Kidney X-ray examination after the administration of uroselectan intravenously. Films taken thirty, fifty, seventy, ninety, one hundred and ten, and one hundred and thirty minutes after injection.

First film (30 min. after injection): On the left side no density is noted. On the right side a rather smooth, dilated pelvis, with beginning filling of the ureter, is noted.

Second film (50 min. after injection): Nothing to be seen on the left side and on the right there is what appears to be an ir-

regular pelvis of the kidney, together with a dilated ureter extending down as far as the crest of the ilium.

Third film (70 min. after injection): Patient was instructed to empty his bladder before this film was taken. On the right side there is a large dilated irregular pelvis with a dilated ureter extending down just below the crest of the ilium. On the left side there is nothing to be seen.

Fourth film (90 min. after injection): On the right side the kidney is clearly outlined and the dilated ureter can be seen extending all the way down to the bladder. Again, there is nothing to be seen on the left side.

Fifth film (110 min. after injection): This fifth film shows the same as the fourth, but not quite so sharply outlined.

Sixth film (130 min. after injection): The patient was instructed to empty the bladder before this film was taken. It shows the dilated pelvis of the right kidney. The ureter does not show except faintly in its lower portion in the region of the bladder. On the left side there is a faint streak-like shadow about the size of a pencil. This may represent a ureter.

Diagnosis.—Markedly pathologic kidney on the right side, with absent or markedly delayed functioning on the left.

Case 2. P. S. R., male, aged 29. There was generalized tuberculosis of both lungs, larynx, intestine, and epididymis, with fever, cough, expectoration, night sweats, marked frequency, and pain on urination. Ascending pyelography was extremely painful and the patient affirmed that he had been worse following the procedure.

Uroselectan was administered intravenously and films were taken at the following intervals:

Thirty-five minutes after injection (Fig. 1): There is a ragged shadow on the right side of rather unusual shape that may represent the pelvis of the kidney and the upper portion of the ureter, although this is extremely problematical. On the left side the kidney and the calices are sharply outlined and the ureter is quite markedly dilated.

Fig. 5. Case 3. Film taken 110 minutes after injection.

Ninety minutes after injection (Fig. 2): The same shadow as previously described on the right side is still present. On the left side the ureter is more distinctly outlined and there is a marked kink in its upper third. The bladder is quite well filled.

One hundred and twenty minutes after injection (Fig. 3): The shadow on the right side is still present and in none of the three films is the right ureter visualized. On this film there appears to be the outline of the right kidney markedly increased in size. The kidney on the left side is also increased in size. Dilatation and deformity of left kidney pelvis, dilatation and kink of left ureter, left pelvis and ureter unchanged since the 90-minute film.

Diagnosis.—Deformity of the left kidney pelvis, dilatation and kinking of left ureter. Almost complete absence of excretion from the right kidney.

Fig. 6. Case 3. Film taken 175 minutes after injection.

Case 3. E. C. K., male, aged 32. No evidence of pulmonary tuberculosis on physical or X-ray examinatoin. Prominent symptoms are painful and frequent urination, with constant pain over the bladder region, and occasional passing of bloody urine.

Cystoscopic Examination.—Highly inflamed bladder wall; ureteral orifices located but impossible to pass ureteral catheters.

Urogram by intravenous method, with the following findings:

Thirty minutes after injection: There is considerable gas in the bowel, but, in spite of this, the kidney pelves on both sides seem to be tremendously enlarged. There is marked dilatation of the ureter on both sides.

Seventy-five minutes after injection (Fig. 4): The kidney pelvis on the right side is markedly increased in size and this also applies to the left side, and the ureter is extremely irregular.

One hundred and ten minutes after injection (Fig. 5): The bladder has been emptied and the lower end of the ureter on the right seems to be about as large in circumference as a thumb.

One hundred and seventy-five minutes after injection (Fig. 6): The kidney pelves on both sides are still outlined and the ureters are quite distinct on both sides and markedly enlarged.

Diagnosis.—Marked deformity of both kidneys, partial obstruction and dilatation of both ureters.

CONCLUSIONS

It is not our purpose in presenting these cases to do other than show that the method is safe and painless in renal tuberculosis and that surprising anatomical changes, much more extensive than one would be led to believe from the symptomatology alone, can be noted in the kidneys in individuals with renal tuberculosis. A careful study of a larger number of cases, utilizing this new method in conjunction with the older chemical, functional, bacteriological, and anatomical methods, will most surely increase our knowledge of renal tuberculosis.

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(2) KEARNS, WALTER M.: Pyelography in Renal Tuberculosis. RADIOLOGY, August, 1927, IX, 109.
(3) Quoted by Kearns (2), which see.
(4) HIRSCH, I. SETH: Urography by Uroselectan. RADIOLOGY, October, 1930, XV, 480.

OBSTRUCTIVE LESIONS OF THE SMALL BOWEL[1]

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THE value of the roentgen-ray examination in the diagnosis of intestinal obstruction was first pointed out by James T. Case. During the last fifteen years he has written several papers on this subject and now it is almost impossible to make any observation not already described by him. His pioneer work did not receive the general acceptance and prompt adoption it deserved. During the last two years, however, the literature on the subject has been greatly augmented.

Cases of intestinal obstruction fall into one of the following groups:

(1) Those in which a clear-cut, definite clinical diagnosis can be made and in which the findings localize the site of the obstruction.

(2) Those in which the clinical diagnosis is definite but in which there are no localizing symptoms or findings.

Fig. 1. Acute obstruction with typical herring-bone formation. At operation the obstruction was found to be due to a loop of bowel knotted beneath a band of adhesions.

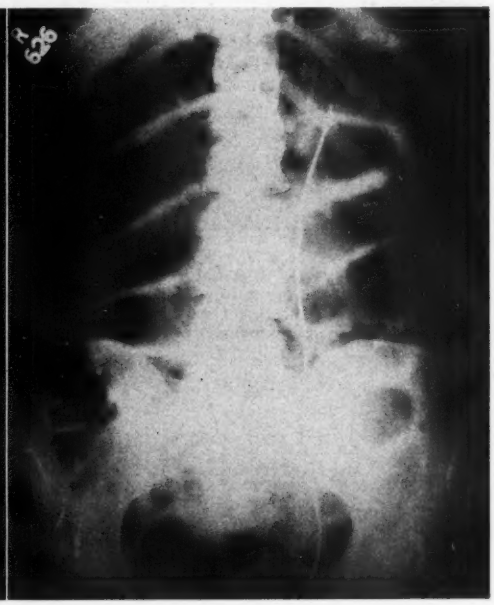

Fig. 2. Acute obstruction showing both the herring-bone and ladder patterns. Stricture of the ureter suspected and the roentgen findings were the first indication of obstruction.

(3) Those in which the diagnosis is uncertain.

(4) Those in which the diagnosis is not even suspected by the clinician.

Whenever there is any doubt about the presence or location of an obstruction, *i.e.*, in the last three groups, there is an indication for a roentgenologic examination. The extent of the examination and the amount

[1]Read before the Radiological Society of North America, at Los Angeles, Calif., Dec. 1-5, 1930, at its Sixteenth Annual Meeting.

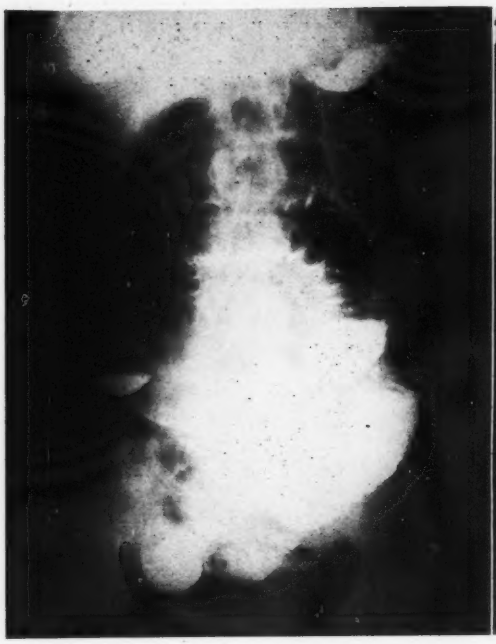

Fig. 3. Same case as shown in Figure 2. Barium had to be given to convince the clinician. Film, made in the erect posture, shows fluid levels. Diagnosis confirmed by operation.

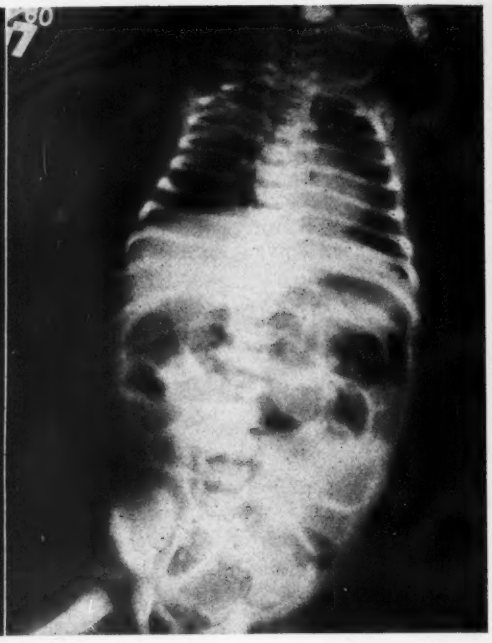

Fig. 4. Distended loops of small bowel in an infant 9 days old. Congenital absence of the colon. The loops show no herring-bone or ladder formation. This may be due to the fact that the mesentery is not completely developed.

of work required will depend largely upon how acute and how complete is the obstruction.

If the roentgen examination is to be of much benefit in the acute cases, it is of utmost importance that the examination be completed quickly and with minimal tax upon the strength of the patient. These acute obstructions usually develop soon after an operation. The patient is in a hospital and facilities for the examination are at hand. If the condition of the patient is satisfactory, the examination should be made in the laboratory where a motor-driven Bucky fluoroscopic table is available. It is important to make this examination in both the supine and erect positions, and with the motor-driven table both fluoroscopic and radiographic studies can be made without any exertion on the part of the patient. If the patient cannot be removed from his bed, roentgenograms can be made in two planes without moving him and a great deal of information obtained. In acute cases, this usually represents all the work that is required and a report can be returned within from fifteen to thirty minutes after the examination has been requested. This procedure fulfills the requirements that no time be lost and the strength of the patient be conserved.

In cases of acute obstruction, the surgeon finds the lumen of the small intestines distended with gas and fluid proximal to the point of obstruction, and collapsed distal to this point. The roentgenologic diagnosis is based upon this same finding. While small amounts of gas may exist normally in the small bowel, the only collections of gas seen on the radiographs of normal individuals

Fig. 5. Distended loop of small intestine six hours after the ingestion of barium. Obstruction was caused by a mass of enlarged glands in a case of Hodgkin's disease.

Fig. 6. Same case as shown in Figure 5. The same loop of distended bowel twenty-four hours after the meal. This loop was not distended with gas on the preliminary film.

occur in the stomach and colon. Collections of gas in the small bowel are, therefore, always significant, and, when the additional signs of distention and fluid levels are present, definite criteria for the diagnosis of obstruction may be said to exist. The fluid may be easily overlooked unless the patient is examined in two planes, preferably the supine and the erect postures.

Usually the appearance and distribution of the gas enable the roentgenologist to determine its location. In the small bowel haustral markings are absent, while the valvulæ conniventes stand out prominently. Case has described this appearance as the "herring-bone pattern." He has also described a "ladder pattern" in which the dilated loops of intestine show a tendency to arrange themselves in parallel rows, like the rungs of a ladder. He believes that the recognition of valvulæ conniventes or Kerkring's folds in dilated, parallel loops of small intestines should be construed as an indication for surgical intervention.

How soon does gas accumulate following an obstruction? Wangensteen and Lynch produced obstruction experimentally in dogs and made roentgenograms at frequent intervals. They found that gaseous distention of the obstructed loops began in from four to five hours. This distention was very marked on the roentgenograms in from twenty to twenty-four hours, although clinically no distention could be made out. They conclude that plain films of the abdomen afford the most reliable method of making an early diagnosis. Douglass believes the two patterns described by Case, while diagnostic, come rather late. He believes one or two distended loops, in the presence of clinical signs, complete the diagnosis. Rabwin also warns that obstruction which results in early gangrene may not cause dis-

Fig. 7. Several areas of distended ileum separated by narrow zones of constriction. The diagnosis of dense fibrous bands of adhesions was confirmed at operation.

Fig. 8. Annular carcinoma of the ileum causing marked distention and stasis. Note the annular shadows above the right ala of the sacrum due to grains of uncooked rice eaten twenty-eight hours before the examination.

tention with gas and that this type of obstruction may give negative roentgenologic findings.

In my experience, the herring-bone appearance and the ladder arrangement describe the appearance in adults very well. In the only two cases occurring in infants which I have had an opportunity to examine, these patterns were absent, although the loops of small intestines were distended. No explanation can be offered for this observation and perhaps a larger number would show these patterns to predominate also in infants.

Wangensteen and Lynch found it unnecessary to give barium to make the diagnosis in their experiments on dogs, but in those cases in which it was given, twenty hours were required for the barium to reach the point of obstruction. In cases of acute obstruction there is no time for a long study with barium, and this is fortunate, as its administration increases the risk at the time of operation.

In chronic or partial obstruction there may be no distended loops of small bowel and no information obtained on what Davis calls the "scout film." In this type of case the administration of barium is necessary to make the diagnosis. It is also in this type of case that the diagnosis is most often doubtful and the need for immediate interference not so urgent. Within this group fall the neoplasms—both benign and malignant—and it must be remembered that the early detection and localization of the latter lesions determine the success of the treatment. The examination with the ingested meal, which may require forty-eight hours, is permissible. Thus far no untoward effects have been observed.

There are two reliable roentgen signs of

partial obstruction. One is dilatation of the lumen proximal to the obstruction and the other is a disturbance in motility. The slowing up and damming back of the current is manifest throughout the small intestine, and there may even be a gastric retention. The delay becomes progressively more pronounced until the point of obstruction is reached. After passing this point the normal progress of the meal is resumed. It is important for the roentgenologist to know the normal motility for the opaque mixture he is employing. This will vary somewhat, depending upon how much fat and carbohydrate are added to the barium. Delayed motility due to obstruction must not be confused with stasis in the small bowel without mechanical obstruction. Stasis usually occurs in the ileum and may be associated with no organic lesion. Lesions in the colon, especially the right half of the colon, must be ruled out and the possibility of a regurgitation through the ileocecal valve must be considered. The finding of barium at the twenty-four-hour observation is always significant and, in the absence of a lesion in the colon, generally means an obstructive lesion in the terminal ileum. While there is delayed motility in both stasis and obstruction in the former, dilatation of the lumen does not occur.

Practically all lesions of the small bowel which give positive roentgenologic findings manifest themselves in the same way, *i.e.*, by producing obstruction. Intestinal tuberculosis is a notable exception. However, there is usually no characteristic roentgen finding that enables the observer to tell the type of lesion present in a given case. I have seen intestinal obstruction following congenital malformations, adhesions, and neoplasms—tumors both intrinsic and extrinsic to the intestinal tract. Usually the latter displace the freely movable coils of small intestine and do not produce obstruction. I have seen two cases in which the obstruction was due to extrinsic pressure. One was in the retroperitoneal portion of the duodenum where the lumen of the bowel was occluded by the pressure from an aneurysm of the abdominal aorta. The other was from the enlarged mesenteric glands in a case of abdominal Hodgkin's disease.

Clinical aids and experience can sometimes assist in determining the type of lesion present. Paralytic ileus cannot be differentiated from mechanical obstruction by the radiograph alone; however, differentiation can be made by the radiograph plus the stethoscope. A questionable area can be palpated under fluoroscopic visualization and a mass found which otherwise may have escaped detection. If this mass is not the distended bowel but is situated just distal to it, a neoplasm is suggested. In one case in which there was a series of dilated coiled loops, separated by narrow zones of constriction, a diagnosis of fibrous bands of adhesions was confirmed at operation. The contention of Soper and Thompson that the dense fibrous bands of adhesions are the type most likely to produce destruction seems well founded, but, in the great majority of cases the roentgenologist should be content with merely reporting the presence and, if possible, the location of the obstruction.

Roentgenologists in general appreciate the possibilities of recognizing these lesions but they also know that the medical profession as a whole does not recognize and utilize this method as it should, especially in the acute cases. There is a tendency to overestimate its dangers.

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An account is given of a visit to various clinics in Paris of the Visiting Association of Throat and Ear Surgeons of Great Britain. Mention is made of a series of excellent cases which had been treated by deep X-ray therapy at the Radium Institute (Institut Curie). These comprised patients with malignant disease of the vertebral column, of the aryepiglottic fold, vallecula, epiglottis, tonsil, etc., several of whom had, in addition, secondary deposits in the neck. The results were very remarkable and all the patients exhibited had been free from recurrence for from five to seven years.

The details of treatment were discussed and it was said that in some cases as much as 37 hours of treatment, spread over 25 days (from one to two hours a day), was necessary. A sinus pyriformis case had 29 hours, spread over 33 days. It would appear that 28 per cent of intrinsic laryngeal cases do well. Extrinsic cases also do well but these may develop thoracic and abdominal metastases.

In addition, a series of patients who had previously had cancer of the tongue was exhibited. Drawings of the condition before treatment and microscopic slides showing the type of growth along with the details of actual radium treatment were also shown. There were several cases in which the disease had been extensive, particularly one treated in 1923 by block dissection of the neck and subsequent radiation, in which there was no recurrence.

At the Hôpital Tenon, Dr. Hautant and his assistants showed many interesting operations, in which radium was used as an accessory to the ordinary surgical procedure. Amongst others were seen a partial excision of the superior maxilla for carcinoma of the alveolus and application of radium tubes to the pterygomaxillary fossa; also a carcinoma of the antrum which was being treated by resection of the anterior wall through a sublabial incision and, at the end, an insertion of three radium tubes into the cavity (7 millicuries for four days). The good results obtained by this procedure were illustrated by four patients in whom a similar operation and radium application had been made from three to five years previously, and in whom there was no recurrence.

At the Hôpital Laennec, a demonstration of X-ray films in mastoid disease, with temporotympanic exposure, was given. Dr. Clovis Vincent at the Lariboisière discussed the taking of roentgenograms of the skull in the antero-posterior direction and from above down, to show the petrous bones and internal acoustic meatus and the alteration of the affected one.

THE PATHOLOGY OF THE SMALL BOWEL, WITH SPECIAL REFERENCE TO X-RAY DIAGNOSIS[1]

By JAMES L. McKNIGHT, M.D., TUCSON, ARIZONA

I PRESENT to you to-day no scientific treatise but just a review of some conditions which come to the roentgenologist in a small city far from the great medical centers and where there are few opportunities to come in touch with the leaders in our specialty.

More and more every year the surgeon and the physician are looking to the roentgenologist for aid in the diagnosis of disease. In no class of diseases is this more true than in those affecting the gastro-intestinal tract. Thanks to such men as Cole, Alvarez (1), Brown and Sampson (2) and others, we are now able to render much more help to the practitioner than was formerly possible.

To enter to-day into any extended discussion of the underlying principles of anatomy, physiology, muscular activity, and especially of the difficult problems of innervation, extrinsic and intrinsic, inherent contractility of muscle structure, sympathetic reflexes, association with diseases of the gall bladder and the appendix, is manifestly impossible. This you will find in the writings of such men as I have mentioned. Suffice it to say that diagnosis is made by observation of abnormalities in position, contour, and motility of the bowel.

Among the pathological conditions of the small bowel, I mention first that one which in frequency appears dominant, namely, duodenal ulcer. Whether or not we accept the so-called cap as the proximal part of the small bowel or the distal part of the stomach need not matter at this time. Here we have the most common site of intestinal ulcer. Dwyer and Blackford (3), in an analysis of three thousand cases presenting complaints of digestive disturbance, found 15 per cent showing ulcer of the stomach or duodenum. Duodenal ulcer occurred five times more frequently than gastric ulcer. My own observation would put the ratio considerably higher but I have no exact figures to offer at this time.

The X-ray findings in duodenal ulcer are preëminently of two kinds: Disturbance of motility of the stomach and of the cap and filling defects and deformity of the cap. In many of these cases we find violent hyperperistalsis and very rapid, complete emptying of the stomach; in others, an early hyperperistalsis and rapid emptying, eventuating in exhaustion of stomach musculature and marked six-hour retention. In an old ulcer, with thickening, there may be extensive stomach retention and even dilatation and hypoperistalsis. The diagnosis of ulcer of the duodenum takes on great importance when we consider its frequency and gravity and the great need of appropriate treatment.

Next I call your attention to the diagnosis of tuberculous ulceration. We are prone to think only of large bowel involvement, but we must remember that in a large percentage of cases the small bowel also is involved. About 80 per cent of all terminal cases of pulmonary tuberculosis have a complicating ulceration of the bowel. After spending more than twenty years in tuberculosis work, I know of no means of diagnosis of tuberculosis of the bowel which will definitely separate the 80 per cent theoretically involved from the 20 per cent not involved, except by X-ray examination. The symptomatology of tuberculosis of the bowel is notoriously uncertain and misleading. Many cases are overlooked entirely and are found only at autopsy. I have seen at autopsy ex-

[1]Read before the Radiological Society of North America at the Sixteenth Annual Meeting, at Los Angeles, Dec. 1–5, 1931.

tremely advanced cases of tuberculous ulceration in which the only symptomatology had been a slight degree of constipation. The presence of diarrhea is suggestive but proves nothing. Pain and tenderness are usually present to some degree, usually not severe, most likely to be found in the lower right quadrant and possibly due to a chronic appendicitis, a condition very frequently present in tuberculous patients. So we cannot diagnose ulceration on the presence of pain. The presence of the tubercle bacillus in the stool proves nothing, of course. There is no clinical sign or symptom on which we can depend. True, in advanced, hopeless cases, the complex of symptoms is fairly conclusive, but by this time we are usually too late for effective treatment.

I believe that in no other disease can the roentgenologist be of more real value to the practitioner than in the early and definite diagnosis of tuberculosis of the bowel. Contrary to our former belief, this condition does respond to appropriate treatment and the patients do get well. The criteria for diagnosis of ulceration of the small bowel are essentially the same as in the large bowel; that is, irritability, intolerance of segments to the presence of the barium, spasticity, segmentation.

Following the methods laid down by Brown and Sampson (2), I consider the diagnosis of tuberculosis of the bowel one of the easiest and most accurate of all the conditions with which we have to deal in roentgenologic diagnosis. Dealing, as we do in Tucson, with a great number of tuberculous individuals, we have found the X-ray diagnosis of tuberculous ulceration of the bowel satisfactory and reliable and of extreme value to the patient, provided his pulmonary condition is not too far advanced and the ulceration not too widespread.

It has seemed to me that many of us have been too conservative—too timid, if you please—in the X-ray diagnosis of tuberculous ulceration. I have seen too many X-ray diagnoses guarded by the qualifying phrase, "In view of the fact that this patient is known to have advanced pulmonary tuberculosis, the X-ray findings should be interpreted as indicating tuberculosis of the bowel." The writer holds the view that this is little more than a percentage diagnosis. It must be remembered that patients die of pulmonary tuberculosis with no involvement of the bowel, and furthermore, that involvement of the bowel occurs in cases with little evidence of activity in the lungs and may be the dominating condition present. I believe that the X-ray diagnosis should be made on the X-ray findings only, allowing the clinician to correlate these findings with the clinical evidence. To do otherwise is to read into the radiographic picture what one thinks ought to appear and leads to egregious error, defeating the very purpose of the X-ray examination.

Next I mention a condition of great importance, namely, stasis in the small bowel. Kornblum (5) lists the causes of small bowel stasis as follows:

(A) Ileal stasis due to lesions in large bowel or terminal ileum.

(B) Generalized small intestinal stasis due to—

(1) Extrinsic lesions producing mechanical obstruction;
(a) adhesions, *(b)* subacute and chronic peritonitis, *(c)* ascites;

(2) Intrinsic lesions involving the lumen of the small intestine;
(a) ulcers, *(b)* diverticula, *(c)* polyps, *(d)* primary neoplasms;

(3) Disturbance in the nervous mechanism;
(a) splanchnic inhibition, *(b)* drugs.

To this list I wish to add one more—that is, stasis due to ptosis. I wish to stress, somewhat, this last-named condition for the reason that I believe it has not been

given sufficient attention by physicians and surgeons generally. Visceroptosis, I would divide into two classes: Clinical and non-clinical. Very often the patient is informed that ptosis is of no importance and requires no treatment. In what I class as non-clinical cases, this is, of course, true. However, there is a rather large percentage of these cases in which such a statement is not correct. In these, we have a duodenal stasis due to the dragging of the ptotic stomach on the relatively fixed duodenum. The victim of this condition is undernourished, unhappy, neurasthenic, lacking in energy, subject to dragging discomfort or actual pain at the site of the duodenum. It is useless to tell this type of patient that ptosis amounts to nothing. Such advice only drives him—or more often her—from doctor to doctor, in all probability to fall into the hands of quacks of one kind or another.

Beilin's (5) excellent article on this condition bases the diagnosis entirely on fluoroscopic and palpatory findings. My own conclusions, through force of peculiar circumstances, are based entirely on the radiographic evidence. His method may be better —either method brings one to the same conclusion. This type of case ought to have careful and persistent treatment.

I next refer to intestinal stasis due to peritonitis and cite a case representing tuberculosis of the peritoneum. The diagnosis in this case was confirmed by exploratory operation and at autopsy. In the film one could note the irregular filling and segmentation.

Diverticula of the small bowel are not very uncommon. I cite a case of diverticulitis involving the duodenum, in a patient, the wife of a physician, aged 60 years. There was no previous history of this condition and no previous radiographs had been made. The patient suffered from moderate pain, with some nausea. Recovery occurred after a few weeks of dietetic treatment and the symptoms have not returned. I might cite another case of diverticulum at almost the exact location of the first. In this instance the patient is a cowboy on an Arizona ranch. The symptoms are much the same as described above.

I next call your attention to intestinal stasis due to extrinsic neoplasm. The patient, a little child, suffered intensely from vomiting, and when brought to the referring physician was in a very bad condition due to extreme dehydration and starvation. X-ray diagnosis of incomplete obstruction of the small bowel was made. For a time, improvement occurred under medical and dietetic treatment, but soon the symptoms recurred with great severity. Exploratory operation was done by Dr. C. A. Thomas, of Tucson, by whose courtesy this case is mentioned. Inoperable lymphosarcoma was diagnosed and the abdomen closed. Death of the child followed soon after.

A case of intestinal obstruction of unknown etiology is now cited, occurring in a child about ten years of age who suffered from epileptiform seizures. This case unfortunately drifted away from the referring physician and we were not able to determine the cause of the obstruction or to determine whether or not this condition had to do with epileptiform attacks.

Finally, I call attention to incomplete obstruction of the small bowel due to adhesions. The case cited has been of considerable interest inasmuch as there has been wide difference of opinion as to the exact nature of the pathology. The patient, a man about 50 years of age, has suffered for the past three and one-half years with rather frequent attacks of excruciating, paroxysmal pain, rather general over the lower abdomen but centering especially over the region of the cecum and terminal ileum. These attacks are peculiarly colicky in character and are accompanied with much gaseous distention not relieved by enema. The pains recur much like labor pains in a woman. Momen-

tary relief is obtained on the passage of gas and fluid past the constricted point. This occurs at intervals of a few moments and with a gurgling noise that can be heard at a distance of ten feet or more from the bed. On a carefully supervised soft, meat-free diet this patient is quite comfortable and is gaining weight. Operation has been avoided for the reason that active pulmonary tuberculosis is present.

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DISCUSSION[1]

Dr. K. S. Davis (Los Angeles, Calif.): The small intestine can well be termed the silent area of the gastro-intestinal tract, for if the roentgenologist has not had his attention directed particularly to this organ it is very easy to overlook lesions in which the findings are not outstanding.

In our routine gastro-intestinal examination a six-hour study is made, chiefly to note the emptying time of the stomach and to observe the motility of the barium through the small bowel. In this examination one can, in certain cases, detect variations not only in the motility of the barium but also in the size, contour, and position of the small bowel. Palpation may reveal a fixation, tenderness, palpable mass, and even at times a loss of normal flexibility of the bowel wall. Usually, however, the roentgenographic diagnosis of a lesion of the small intestine is based on the findings of obstruction, either a hypomotility of the barium or a distention of the gut above the obstructed site, depending on the degree of involvement. The detection of a true hypermotility of the barium through a given part of the small bowel presents great difficulties, especially when one recalls the great rapidity with which the barium meal passes through this part of the intestinal tract. The normal limit for a complete evacuation of the small bowel varies from six to fifteen hours. No conclusions can be drawn from any variations from the normal unless the emptying time of the stomach has been carefully taken into consideration.

Dr. McKnight in his paper has listed many causes of stasis in the small bowel. To these I would like to add two more: (1) A slow emptying of the stomach, which probably is the most important cause of a hypomotility of the barium in the six-hour study; (2) stasis of the barium in the terminal ileum as the result of an appendicitis.

In my experience the majority of the diverticula of the small bowel have been located in the first and second portions of the duodenum. Most of these have been symptomless. It is extremely difficult to differentiate between a true diverticulum and a dilated ampulla of Vater on the basis of roentgenographic findings alone.

In the diagnosis of visceroptosis one must be extremely guarded in his opinion, as one can very easily make a life-long invalid of his patient. If the stomach empties normally and the motility of the barium through the small bowel is within the limits of normal, the relative position of the stomach in the abdomen makes but little difference in the health of the patient.

As regards the roentgenographic findings in obstruction I can do no more than reiterate what Dr. Heacock has already said. During the past five years at St. Vincent's Hospital we have had thirty-two cases of obstruction in the small bowel on which X-ray studies had been made prior to operation or autopsy. Of these cases, six were of the chronic type re-

[1]The papers of Dr. Heacock (page 119) and Dr. McKnight (page 125) were discussed together.

quiring no immediate surgery, the lesion being diagnosed as a result of the motor meal examination. The balance of these cases was almost equally divided between a paralytic ileus and an acute complete mechanical obstruction. I know of no way in which one can definitely state on the basis of a flat plate alone whether the lesion is due to mechanical obstruction or ileus. I do believe that with gas present in the intestine distal to the dilated loops of small bowel, the presumption should be that of ileus and not of obstruction.

A review of these cases in view of the operative and autopsy findings brings out some interesting facts.

(1) The X-ray findings must be carefully co-ordinated with the history and physical findings.

(2) Negative X-ray findings must be ignored by the surgeon in a case with a clear-cut history and physical findings of obstruction.

(3) The location of the gas-filled coils of small bowel on the film has in a certain percentage of cases no relation to the part of the bowel obstructed. However, in most of the cases the approximate location can be quite accurately determined.

(4) Cases with gangrene of the bowel fail to give any demonstrable distention of the bowel with gas, and the "scout" roentgenograms are usually interpreted as negative.

(5) An extremely marked distention of the small bowel may occur in cases of urinary calculus.

(6) Incomplete obstruction has never yet in my series of cases given us positive findings on the "scout" plate.

(7) In very young babies the "scout" plate is of no value in determining the site of the obstruction as the small bowel becomes so enormously distended that it cannot be differentiated from the shadow of a distended colon.

Dr. H. B. Thompson (Seattle, Wash.): I would like to tell you of one mistake I made in the diagnosis on a case which corroborates what Dr. Heacock says. This patient had been operated on for a simple appendix and allowed to leave the hospital after one week. Immediately upon arriving home, he began to vomit. The Doctor told me about the symptoms and I made a diagnosis of obstruction before I saw the patient. He was in the hospital three or four days later and a film was made which showed a very marked enlargement of the small intestines. The enlargement, however, was so marked that it was really larger than most enlarged colons which one sees. One loop of bowel went up on the right side, corresponding to the ascending colon, straight across the upper portion of the abdomen, and down on the left side. I had made the diagnosis before I saw the patient, so I did not look at the film carefully enough to see the valvulæ markings in some of these loops. They were not very distinct, but the outline of the small intestines so nearly followed the large bowel that I made a definite diagnosis of obstruction of the large bowel down in the terminal portion. At operation it was found in the small bowel. If I had paid the proper attention to the markings, I would not have made this mistake.

I wish to ask Dr. McKnight one question; that is, on the film showing the slight obstruction or delay in the second portion of the duodenum—I believe he attributed a patient's symptoms to this slight obstruction—I would like to know how he arrives at this conclusion. Is it not reasonable to assume that the patient's general condition which produced the ptosis, neurasthenia, etc., was accountable for the delay in the small bowel—that it was secondary and not really a part of the patient's symptoms?

Dr. Kenneth D. A. Allen (Denver, Colo.): Within a year, a very capable internist came to me after I had rendered him an opinion of chronic small intestinal stenosis on his patient, and said that he had no idea the X-ray could give information about the small intestine. He has been practising medicine a good many years and has asked for many gastro-intestinal X-ray examinations and was not aware that the X-ray could demonstrate many lesions of the small intestines. Early chronic small intestinal stenosis is dif-

ficult to demonstrate. A case must be studied by X-ray every hour after the motor meal in order to get evidence of early chronic stenosis, and therefore we have, all of us, overlooked early cases.

I have had two cases of chronic small intestinal stenosis within two years from a different cause than any outlined in Dr. Heacock's valuable paper. Both of them were caused by a breaking down of a lymph node which had been infected, a lymph node in the mesentery, close to the small bowel. Following the infection the lymph node area filled in with connective tissue which gradually reached out around the small intestine. Both of these cases were proven by a microscopic examination. Slowly the small intestine became stenosed. This process leads to a symptom-complex which can help us greatly in suspecting these cases. One of the cardinal symptoms of the small intestinal stenosis is repeated attacks of vomiting, distention, and pain, and if we will make an X-ray examination of one of these patients during an attack, it will be easy to show the cardinal X-ray signs. Between attacks it is much more difficult to demonstrate a lesion. The reason for these attacks probably is that the patient commits a dietary indiscretion, the mucosa becomes inflamed and edematous, and more or less complete stenosis takes place temporarily. In these chronic cases, as Dr. Heacock has said, barium is not harmful, in fact, it finally helps to push through the edematous area.

DR. MCKNIGHT (closing): I have nothing further to say except to answer as well as I can the question asked. I think probably the wording of the paper is a little misleading. What I mean to say is that when ptosis reaches a degree which, by its dragging and pulling on the more or less fixed duodenum, causes stasis in the duodenum, you do have symptoms. In other words, when you see ptosis showing persistent duodenal stasis, one may be sure that that patient is having symptoms and you will not miss it by very far if you call up that patient's physician and say, "Your patient is complaining of nervousness, abdominal discomfort, nausea, and probably more or less vomiting."

SPECTRUM OF THE RADIATION FROM A HIGH POTENTIAL X-RAY TUBE[1]

By C. C. LAURITSEN, California Institute of Technology, PASADENA, CALIFORNIA

Abstract.—A spectrograph of the Seemann type has been constructed for the purpose of investigating the radiation from the high potential X-ray tube at the California Institute. A typical spectrogram obtained with 600 kilovolts on the tube is presented. The photometer record shows a continuous spectrum with its maximum intensity at about 200 kilovolts and a short wave length limit in the neighborhood of 600 kilovolts. The range covered is roughly from 100 to 20 x-units. It is proposed to use the apparatus for determining absorption coefficients by photographing the spectrum of radiation which has passed through an absorbing screen. No anomalies of any kind have been observed so far.

APPARATUS

THE high potential X-ray tube at the California Institute of Technology has recently been rebuilt and equipped with a hot cathode and a tungsten target. A description of the tube and its housing has been presented by Lauritsen and Cassen.[2] The tube in its present form operates satisfactorily at 600 kilovolts and it has been deemed advisable to investigate the available radiation before attempting to go to higher potentials.

In order to investigate the region of the X-ray spectrum from approximately 150 kilovolts and up, a crystal spectrograph was constructed following the principle described by Seemann,[3] Siegbahn[4] and others. High precision cannot be expected with any reasonable time of exposure by this method since the whole of this region of the spectrum lies within an angle of less than one degree and thick slits are required because of the great penetrating power of the hard radiation. On the other hand, the method is convenient and sufficiently precise for the approximate determination of the short wave length limit as well as of the general distribution of intensity in the spectrum. Also, if any prominent lines, bands or absorption edges or other unexpected irregularities exist in this region, they should be found most conveniently by this method.

The spectrograph consists essentially of a vertical slit 0.9 mm. wide in a lead block 4 cm. thick, in front of which a rock-salt crystal is placed. The crystal, slit, and photographic plate are all rigidly mounted on a long arm which may be rotated through an angle of one degree on each side of the center, the rotation taking place about an axis through the vertical center line of the slit. Since the focal spot has the appearance of a thin horizontal disk approximately 5 mm. in diameter, it is clear that radiation will reach the central planes of the crystal under all angles from zero to 50 minutes, provided that the distance from the focal spot to the crystal does not exceed 35 cm. and that the spectrograph arm is set at an angle of 25 minutes on either side of the center line through the focal spot and the slit. Under these conditions the undeviated part of the light will produce an image of the focal spot as seen through the slit, the whole of the image being located on one side of and adjacent to the center line of the photographic plate. The reflected portion of the light will appear as a spectrum on the other side of the center line. The short wave

[1] Reprinted by permission from Physical Review, Dec. 15, 1930, XXXVI, 1680–1684.

[2] C. C. Lauritsen and B. Cassen, Phys. Rev., 1930, XXXVI, 988.

[3] Seemann, Phys. Ztschr., 1917, XVIII, 242.

[4] M. Siegbahn, Phil. Mag., 1919, II, 639.

length limit is thus given by the distance from the center line to the edge of the continuous spectrum, and lines of equal wave length are parallel to the center line. Since different wave lengths originate from different lateral regions of the focal spot and since the intensity is not absolutely uniform throughout the whole of the area, it is not possible to obtain the intensity distribution in the spectrum directly with any degree of precision. Correction can, however, be made for this lack of uniformity if the direct beam is reduced by means of a filter to an intensity comparable to the intensity of the spectrum. This is so because the direct beam is a true image of the focal spot and the spectrum is a specular image of the direct beam, except for the wave length selectivity, and there appears to be no good reason why the radiation from different parts of the target should differ appreciably in hardness if the intensity is the same.

Fig. 1. Double spectrum 600 K.V. peak.

The photographic plate is placed 107.5 cm. from the center of the slit. In spite of this comparatively great length, the resolution is not high on account of the wide slit, but it is sufficient for the present purpose.

In order to determine the exact zero on the photographic plate it is most convenient to photograph both right and left hand spectrum on the same plate. This is done by adjusting the spectrograph as described except that the direct image is blocked out completely by a heavy lead screen while one spectrum is being photographed. The spectrograph arm is then rotated into position on the opposite side of the center line and the direct image which now appears on the part of the plate which has been exposed is blocked off. The second exposure thus gives a spectrum on the part of the plate which was covered up during the first exposure. The result is two spectra which are symmetrical with respect to the center line or true zero. Figure 1 is a positive reproduction of a double spectrum taken in this manner.

A dark line may be seen running diagonally through the spectrum in each of the spectra of Figure 1. The origin of this line becomes apparent if we consider the geometry of the arrangement. The spectrum shown is due to reflection from vertical (100) planes of the rock-salt crystal, but if the crystal is adjusted so that the horizontal (100) planes are parallel to a horizontal plane through the focal spot and some part of the photographic plate, then it is clear that from each point of the target there will be a ray of a given wave length which will make the same angle with the horizontal as with the vertical planes. The intensity of this ray will therefore be divided between the spectrum shown and a spectrum which falls above, below, or within the direct image.

This second spectrum is of the type first obtained by Rutherford and Andrade and differs from the first in that the resolution is slightly less. The paths of a ray are shown by the lines *a*, *b*, and *c* in Figure 2, and the heavy lines *d* in the end view are the intersections with the photographic plate of all the rays which fulfill the foregoing condition. It is readily seen from the figure that the angle between the lines *d* and the vertical center line is given by

$$\tan \theta = \frac{b}{a + b}.$$

In the present case, this gives

$$\tan \theta = \frac{107.5}{142.5} = 0.755; \quad \theta = 37.05°$$

which agrees with the angles made by the dark lines in Figure 1 with the center line.

The intensity distribution was obtained by means of a recording microphotometer. In Figure 3 the galvanometer deflections obtained from the photometer records are plotted as ordinates against distance as abscissas. The tube was operated at 600 kilovolts peak and, as indicated in the graph, the short wave length limit corresponds closely to this value. The maximum intensity occurs somewhat below one-half of this potential, as might be expected, since the tube is operated with alternating current and a "thick" target is used. It should be noted, however, that the softer radiation is decreased somewhat in passing through both the 6 mm. steel wall of the tube and the crystal. The lack of symmetry which is apparent in the graph is due partly to the aforementioned non-uniformity of the focal spot and partly to a slight difference in exposure.

RESULTS

From the photograph as well as from the photometer record we may conclude that, within the limits of the resolution used, there are no unexpected irregularities in the spectrum from tungsten in the region covered. At the present time work is in progress to determine as accurately as possible how the spectrum is modified by different absorbers. The right half of Figure 4 shows the spectrum after passing through lead screens. One screen, 0.28 in. thick, covers the whole image, and in addition the central portion is covered by a second screen 0.14 in. thick. The direct beam was decreased to a suitable intensity by a steel block 2 in. thick.

The photometer records of spectra taken in this way show accurately how the spectrum is modified by any given absorber and it should therefore be possible to obtain from a single pair of records the absorption coefficient as a function of the wave length.

If nuclear absorption levels or other unexpected irregularities exist in this region of the spectrum, they should be readily detected by this method. The spectra obtained so far and also the modifications due to absorbing screens of aluminum, iron, copper, and lead are roughly what would be expected. There is no indication of any sudden changes in intensity with wave length.

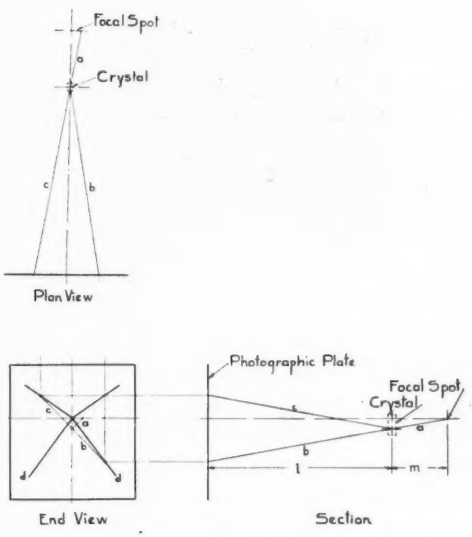

Fig. 2.

REMARKS BY DR. ROBERT A. MILLIKAN[1]

From the year 1921, when it first became assured that the facilities for high-potential high-power experimentation would be available at the California Institute, we have had, as a major element in our research program, the development (if possible) of a vacuum

[1]Before the Radiological Society of North America, at a meeting held in the Norman Bridge Laboratory of Physics, California Institute of Technology, Pasadena, Dec. 3, 1930.

tube which would stand, without breakdown, something like the potentials developed by our million-volt installation. Indeed, one of the chief reasons for my own coming from the University of Chicago to the California Institute was the opportunity afforded by the Institute for assisting in this type of development.

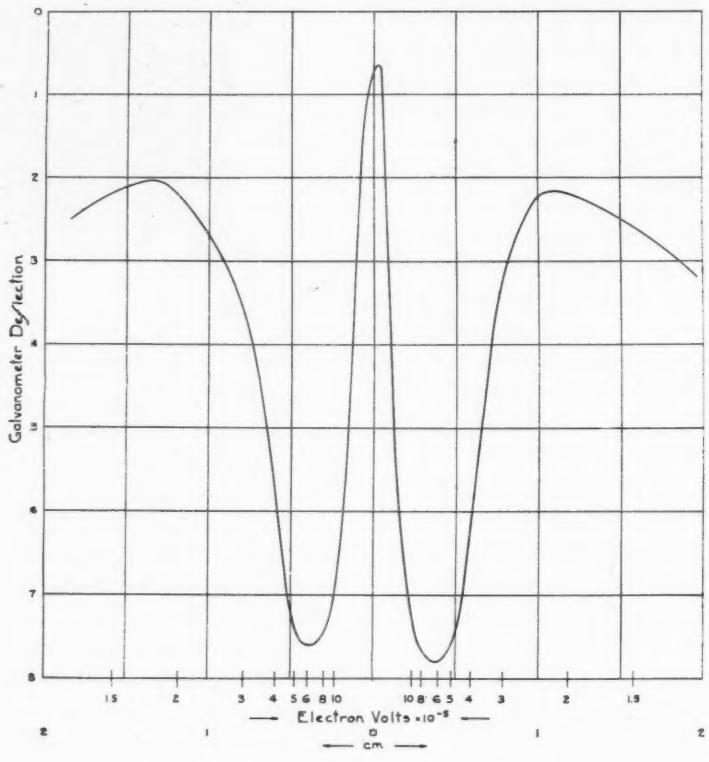

Fig. 3.

After at least three unsuccessful attempts made between 1922 and 1927, the problem was successfully solved by Dr. C. C. Lauritsen in 1928 to this extent. In that year a large one-chamber vacuum tube, with electrodes but a few centimeters apart, was built by him, which did not puncture or break down in any way when potentials up to 750,000 volts were applied to it. The only current that passed through this tube was pulled out of the electrodes by the enormous fields set up at the surfaces or else was induced by the impact against the electrodes of electrons originally pulled out by such fields. The study of the conditions under which currents may be pulled out of cold electrodes by such intense fields has been one of the major activities of our Laboratory since its completion in 1921, and Dr. Lauritsen has been one of the most productive workers in that field. Last Spring he modified his so-called cold emission 750,000-volt tube by putting a hot filament in one of its electrodes. This has two effects: first, it tends to lower somewhat the potential reached, but, second, it renders the flow of energy more uniform and more controllable. The net result is that now a cathode-ray

beam five milliamperes strong and driven by a potential up to 650,000 volts bombards the anticathode and there generates highly penetrating X-rays both of a frequency or penetrating power and of an intensity much higher than have been obtainable thus far. The wave lengths are not far below those of the gamma rays from radium.

There are three types of investigations that are thus opened up by Dr. Lauritsen's accomplishment: first, scientific studies of the properties of these very powerful and very penetrating rays themselves; second, physical studies of the transparencies of metals and other opaque substances with largely increased possibilities for the detection of inhomogeneities or inclusions of one sort or another in large masses of dense materials; third, biological studies of the effects of these rays on living organisms. Dr. Lauritsen proposes to work out all these possibilities, but no conclusions will be drawn before we have enough data to have confidence in the experimental results and in the generalizations that may be drawn from them. In the biological field we ourselves have practically no knowledge at all as yet about the effects of these rays and we probably shall not have for a period of several years. In other words, for a considerable period we shall in all probability have nothing whatever to report beyond what we

Fig. 4. Left, direct image; right, spectrum.

are reporting now. Premature conclusions would be both unscientific and dangerous. An agency of this sort should and will be given long trial before any conclusions can be drawn that have any interest whatever to the general public. When we have learned anything about these rays that is dependable we shall of course publish it and otherwise give it to the public, but not before.

QUANTITATIVE MEASUREMENT OF DIATHERMY DOSAGE

By A. HEMINGWAY, MINNEAPOLIS, MINNESOTA
From the Department of Physiology, University of Minnesota

Abstract.—Evidence is presented which shows that a thermocouple voltmeter together with a thermocouple ammeter would be suitable to measure diathermy heat dosage, since across the tissue the high frequency current and voltage are in phase. Experiments are reported on the heat production by diathermy currents in tissue which show that the heat imparted to the tissue can be computed from the effective high frequency voltage drop across the tissue and the diathermy current.

IT IS the opinion of the majority of clinicians that the sole benefit of diathermy is the production of heat in the tissues. Hitherto, there has been no method of determining the amount of heat energy which a patient has received from a treatment. Dosage has been regulated by the current which traverses the tissues, the current having a value sufficiently low so that burning of the skin at the electrodes does not occur. A knowledge of the value of the electrical current, however, is not sufficient to determine the amount of heat energy which is imparted to the patient.

To measure the heat produced in the patient by diathermy, the true diathermy current must be known and either the true high frequency electrical resistance or the effective high frequency voltage. In the case of the latter it must also be stipulated that the voltage and current are in phase.

In order to measure the electrical resistance of tissues at the alternating current frequency of the diathermy current, much elaborate apparatus and careful technic are required. It has been shown by Gildemeister (1) that the observed electrical resistance of the human body decreases with increasing frequency, and Philippson (2) has shown that to high frequency currents of one million cycles per second and greater, the impedance for increasing frequency remains constant. This constant value is interpreted as the true electrical resistance of the tissue and such an interpretation is supported by the calorimetric measurements in this paper. However, the measurement of the electrical resistance at high frequency, which would give the heat produced when computed by Joule's $(\text{current})^2 \times$ resistance relation, is not practical clinically. Apparatus to measure high frequency resistance is described by McClendon (3), Stratton (4), Fricke (5), Ferguson (6) and others, but a glance at their papers will assure one that such apparatus is too bulky and complex to be used for resistance measurement in a diathermy treatment.

In the use of a voltmeter to measure the diathermy heat dosage, there are several requirements. The heat produced is given by the expression, "current $\times$ voltage $\times$ cosine of phase angle." Only if the cosine of the phase angle is equal to unity may the heat energy be computed from the product of current and voltage. However, the fact that at high frequencies the impedance becomes constant with increasing frequency would satisfy the demand that the cosine of the phase angle is unity. This is true only with widely separated electrodes, as in diathermy, and only with alternating current of the present diathermy frequencies. A further requirement is that the voltmeter record the effective or root mean square voltage and not the peak voltage as measured by vacuum tube voltmeters. Also it is well known that the electrodynamometer volt-

meters used with low frequencies of sixty cycles per second cannot be used, due to their high inductance and distributed capacity.

An instrument which would fulfill these requirements is the recently developed thermocouple voltmeter. This instrument is operated on the same principle as the thermocouple ammeter ordinarily used in diathermy, wherein the small voltmeter current, in traversing a thin resistance heating wire, heats a thermocouple junction which in turn is connected with a sensitive D.C. galvanometer. Such a voltmeter is described by Wilson (7). Voltmeters which would register sufficiently high voltage are not usually made, but one was constructed especially for our purpose by one of the leading manufacturers of electrical instruments.

It is obvious that one cannot use a patient for quantitative calorimetric measurements in diathermy. A suitable equivalent has been found in another way. A section of a potato was placed between electrodes and immersed in a light lubricating oil. The heat generated in the potato tissue due to diathermy current was imparted to the non-conducting oil which was rapidly circulated about the tissue. The potato was perforated to allow circulation of oil through it and sections were chosen whose high frequency electrical resistances were of the order of magnitude of those of a patient in a diathermy treatment. Such a scheme is a suit-

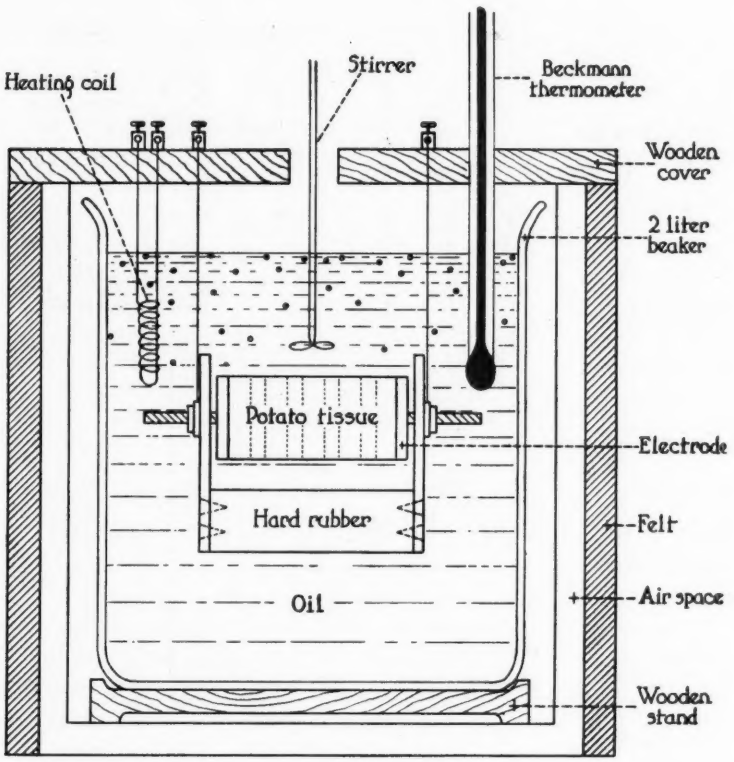

Fig. 1.

able electrical representation of the body tissues, since the cells, due to their membranes, have a high resistance to low frequency alternating current and a low resistance to high frequency A.C. in the same manner as animal tissues. A diagram of the calorimetric arrangement is shown in Figure 1.

To measure the heat capacity of the system a small heating coil of 20-ohms resistance was used with direct current and immersed in the oil, together with the tissue. The voltage drop across the coil when a current of two amperes passed through it was measured as well as the temperature increase ($\triangle T_1$) of the oil and the duration time ($\triangle t_1$) of the current. The temperature was measured by the Beckmann thermometer shown in Figure 1. The heat capacity of the oil, tissue, and coil was accordingly

$$\frac{\text{Volts} \times \text{amperes} \times \triangle t_1}{4.19 \times \triangle T_1} \text{ calories per degree C.} \quad (1)$$

Potato sections of different sizes were used to give different high frequency resistances, the resistances having values of those of a patient to a diathermy current. As shown in an earlier paper (8), these resistances extend from 20 to 150 ohms. Resistances were measured by the high frequency conductivity bridge as used by McClendon (3) and Remington (9). A general scheme of the circuits used is given in Figure 2.

The diathermy current was measured by a calibrated vacuum thermocouple ammeter, while the voltage was measured by the thermocouple voltmeter already described. The temperature increase of the oil, warmed by

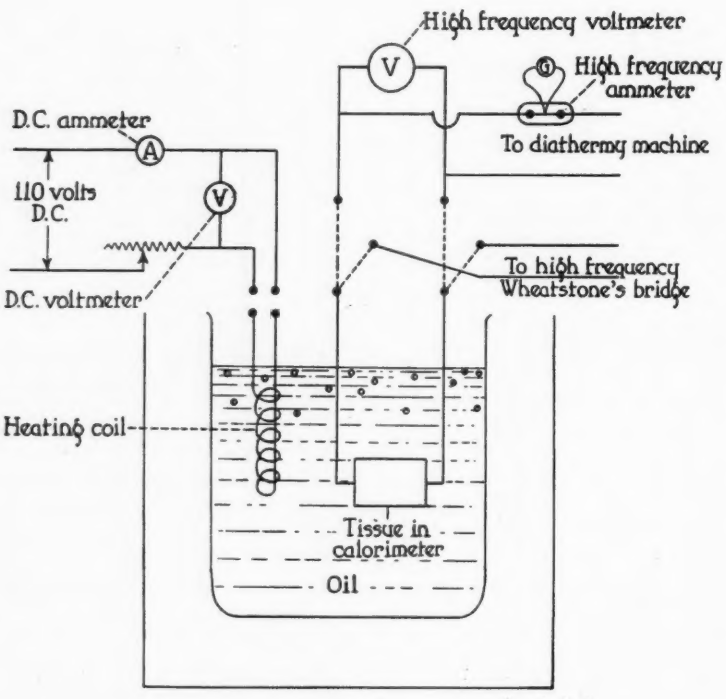

Fig. 2.

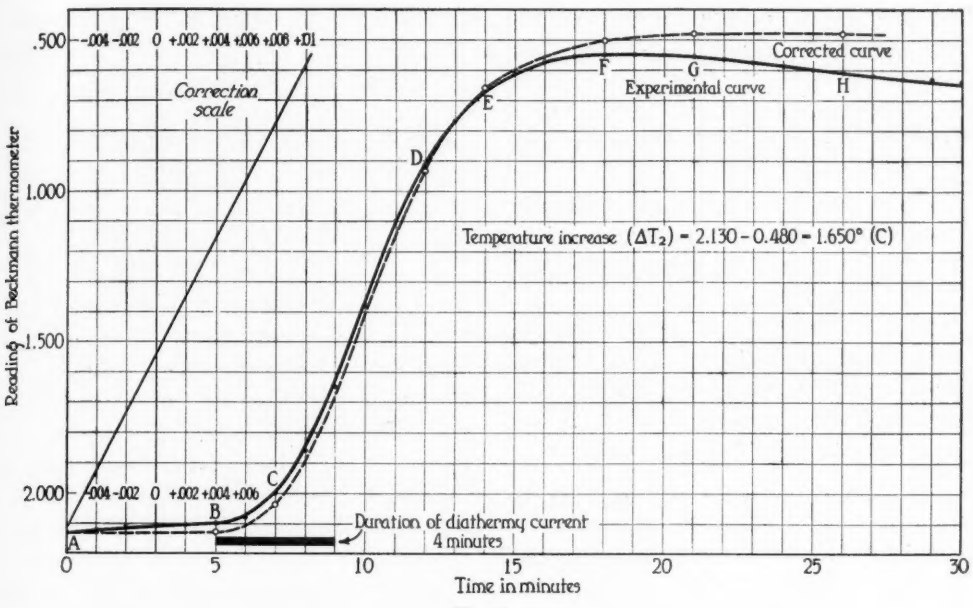

Fig. 3.

heat conduction from the tissue, was measured by the Beckmann thermometer as shown in Figure 1.

In measuring the temperature increase ($\triangle T_2$) of the system, either by the heating coil with D.C. to measure the heat capacity, or by the diathermy current traversing the potato tissue, corrections for two sources of error must be made. These corrections are for (1) heat loss due to radiation where the temperature of the oil is above or below the surroundings, and (2) a slight heat production due to the motion of the stirrer in the viscous oil. Both of these corrections are small, since the temperature difference between oil and surroundings never exceeded 2 degrees C., but, since $\triangle T_2$ had values from 1 to 2 degrees C. and was measured to an accuracy of 0.001 degree C., they were appreciable. Corrections for both of these errors were made simultaneously from a study of the temperature changes before and after the passage of the current. A corrected curve, taking these errors into consideration, was drawn according to the method given by Duncan and Starling (10) and is shown in Figure 3.

Knowing the corrected temperature increase $\triangle T_2$ due to passage of the diathermy current and the heat capacity of the system computed from heating the coil with D.C., the rate of production of heat energy measured as $\frac{\triangle H}{\triangle t_2}$ was computed in watts by the formula

$$\frac{\triangle H}{\triangle t} = \frac{\text{Heat capacity} \times \triangle T}{\triangle t} \text{ watts} \quad (2)$$

The computed energy increase in watts was determined by the product of the diathermy voltage E and the diathermy current I according to

$$\text{Computed heat energy} = E \times I \text{ watts} \quad (3)$$

Since the phase angle is zero (*i.e.*, cosine of phase angle = 1), then the high frequency resistance of the tissue can be computed from the formula

$$\text{Resistance } R = \frac{E}{I} \quad (4)$$

RESULTS

The results of the experiments are con-

tained in Table I, where the symbols have the following meanings:

Column I.—H is the heat capacity of the oil, tissue, and coil system. It is computed according to Equation (1) and given in calories per degree.

Column II.—E is the reading of the high frequency thermocouple voltmeter, giving the effective voltage drop across the tissue due to the diathermy current.

Column III.—I records the diathermy current, as measured by a calibrated vacuum thermocouple ammeter, and from a diathermy machine operating at a frequency of approximately 500 kilocycles.

Column IV.— $\frac{\Delta H}{\Delta t_2}$ is the observed rate at which heat is imparted to the system and is given in watts.

Column V is the computed rate of heat production as determined from a reading of the high frequency voltmeter and ammeter (see Equation 3).

Column VI contains the value of the high frequency resistance as measured by a high frequency Wheatstone bridge at a frequency of one million cycles per second. The method of balancing the tissue in the cell was to use a resistance in series with a capacity.

Column VII gives the resistance computed according to Equation (4) from the observed diathermy voltage and current of Columns II and III.

It will be noticed that for sections with the higher resistances, the resistance as measured by the high frequency conductivity bridge is higher than the resistance computed from the diathermy voltage and current. For these smaller sections of tissue it was noticed that, as the heating progressed, the voltage would decrease and the current increase, giving, therefore, a lower resistance due to the heating of the tissue. The heat was not immediately imparted to the oil, as the temperature-time curves indicate. Average values of the current and voltage for a run were taken. For the larger sections of tissue with the larger tissue heat capacities in which the rise in temperature due to the diathermy current was not very great the two resistance values agree. In the resistance values of the lower row, in Column VI, two values are given. In one case the cold tissue resistance was measured (200 ohms) and in the other the resistance (125 ohms) was measured as soon as the diathermy current was discontinued after a usual run. The purpose in measuring high frequency resistances was merely to have tissue resistances of the order of magnitude of diathermy resistances; therefore, temperature fluctuations and consequently resistance fluctuations, if within the range of diathermy resistances, do not interfere with the technic of the experiment.

TABLE I

I	II	III	IV	V	VI	VII
H Cals. per degree C.	E Volts	I Amperes	$\Delta H/\Delta t_2$ Watts	EI Watts	R Ohms	R Ohms
846	30	0.765	24.3	22.9	39	39.2
846	27.5	0.732	19.7	20.1	39	37.5
725	49.5	0.784	38.2	38.8	65	63.1
725	44.0	0.633	26.3	27.8	65	69.5
798	52.0	0.650	30.0	33.8	100	74.5
798	43.0	0.565	26.6	24.2	100	76.2
810	48.0	0.312	15.0	15.0	125–200	154

These experiments have been repeated using electrolytic solutions. Similar results have been obtained.

CONCLUSIONS

From Columns IV and V of Table I it follows that the heat dosage of diathermy may be computed from the diathermy current and the effective voltage drop across the tissue. The heat energy imparted to a patient in a diathermy treatment in calories may then be calculated from the formula

$$\text{Heat energy} = 0.24\ EIt \text{ calories}$$

where E is the voltage drop, I the diathermy current, and t the time of duration of the treatment. This eliminates the necessity of measuring the high frequency resistance and

computing the heat energy from the formula

$$\text{Heat energy} = 0.24\ I^2Rt.$$

The voltmeter method of measuring diathermy dosage is very practical clinically since the only way that the usual diathermy machine has to be modified is to insert a portable thermocouple voltmeter in parallel with the patient.

In conclusion, I wish to express my appreciation to Dr. W. K. Stenstrom, of the Department of Biophysics, for his interest in this problem and for useful suggestions. I am also very grateful to the Victor X-ray Company for the loan of the diathermy machine which was used in the experiments.

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PULMONARY TUBERCULOSIS IN INFANTS AND CHILDREN[1]

By CARL E. KOENIG, M.D., SEATTLE, WASHINGTON

WHEN roentgenology began to be employed as an aid in the diagnosis of pulmonary tuberculosis the significance of the findings was at first not correctly evaluated. Apparently it was thought that this new method of examination should stand on its own merits and arrive at conclusions in a definite manner similar to that characteristic of it in the diagnosis of fractured bones. Regarding the matter of fractures the evidence was, almost without exception, either positive or negative; while in pulmonary tuberculosis the X-ray findings were in themselves very frequently neither positive nor negative. The assistance of other diagnostic aids was required, and, because a diagnosis was not made independently of these other factors, the value of X-ray evidence was sometimes under-rated.

We know that the relative values of different diagnostic methods are extremely variable. A single factor such as a sputum examination may be highly significant, and, again, it may have no value whatsoever. This is true, in a general sense, of all methods used in diagnosing pulmonary conditions, but it is no more true of X-ray examination than it is of physical examination.

In a physical examination of pulmonary conditions the discovery of numerous moist râles in a subapical region is very suggestive if they are persistent; but the stethoscopic findings, along with all of the other physical findings, are not conclusive. A physical examination must be supported by many or all diagnostic aids before a diagnosis is made, but we do not under-value the importance of physical examination because we find that it is not self-sufficient.

There is an X-ray finding in pulmonary tuberculosis which is comparable in value to the discovery of moist râles. I refer to the persistent presence of parenchymal X-ray lesions in a subapical region. So significant are they that they have been included in the Trudeau Sanatorium "Five Diagnostic Criteria of Pulmonary Tuberculosis" (1). The persistent clinical finding of moist râles in a subapical region also belongs to this list.

Physical or X-ray examinations, in common with other diagnostic aids such as clinical history, laboratory analyses, and skin tests, are rarely sufficient in themselves, but all have value—variable in importance in different cases—in helping to establish a diagnosis.

With this background may we take into consideration the subject of pulmonary tuberculosis as it occurs in infants and children? Here, again, conclusions must be arrived at by deductive reasoning, using all the means at hand, as there are rarely any pathognomonic findings.

Considerable attention is to be given to differential diagnosis, but it is so intimately linked with classification of pulmonary tissue changes that it will be necessary, first, to discuss the different types of lesions.

McPhedran has formulated an excellent outline relative to types of lesions occurring in pulmonary tuberculosis in children (2). They are classified as follows:

Parenchymal lesions:

- *(A)* Focal tuberculosis—caseous or calcified.
- *(B)* Tuberculous consolidation—progressive or unstable.
- *(C)* Tuberculous consolidation—retrogressive or benign.
- *(D)* Diffuse childhood type tuberculous infiltration.

[1]Read before the Radiological Society of North America at the Annual Meeting in Los Angeles, California, Dec. 1–5, 1930.

(E) Miliary tuberculosis.

Tracheobronchial lesions:

(A) Tuberculosis of tracheobronchial lymph nodes, uncalcified.

(B) Tuberculosis of tracheobronchial lymph nodes, calcified.

Lesions of adolescence:

(A) Apical adult type infiltration of children and adolescents.

will hasten on to the discussion of other parenchymal lesions.

Tuberculous consolidation which is progressive or unstable is revealed as a shadow of increased density, conforming in outline to a lobe of a lung or as a roughly wedge-shaped mass. These increase or fluctuate in extent or they excavate.

Tuberculous consolidation, retrogressive and

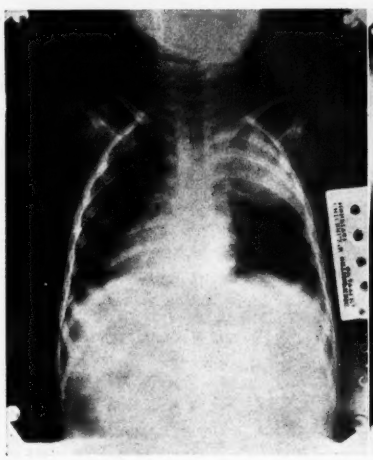

Fig. 1

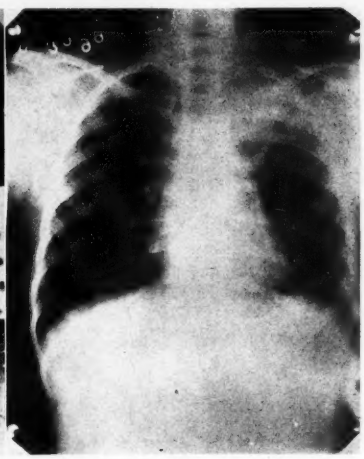

Fig. 2

Fig. 1. Lobar pneumonia, non-tuberculous.
How long sick?—Sick for only a day or two before entering hospital. Recovery in a week or ten days.
How sick?—Onset abrupt. Patient acutely ill, vomiting, convulsive, lethargic, and with high temperature.
Temperature?—High, constant, 103-5 degrees. Dropped by lysis.
Contact?—No history.
D. S., female; age, 4 years (Children's Orthopedic Hospital, Seattle).

Fig. 2. Tuberculous consolidation, progressive.
How long sick?—History of several months' illness.
How sick?—Ambulatory. Came to Out-patient Department of hospital, complaining of cough, loss in weight, anorexia.
Temperature?—Intermittent; P. M.—0.1 to 1.15 degree above normal.
Contact?—No history of exposure. Positive Mantoux.
C. G., male; age, 14 years. (Children's Orthopedic Hospital, Seattle).
Still has large parenchymal lesion, subapical lesion, unchanged two months after first X-ray examination.

McPhedran describes the first-mentioned parenchymal lesion—focal tuberculosis—as "an isolated sharply defined subpleural density" and adds that "it is often obscured by denser structures." When seen, it is a characteristic sign of the existence or previous existence of pulmonary tuberculosis. Because of its characteristic qualities differential diagnosis gives us little concern, so we

benign, is described as a homogeneous wedge-shaped shadow most dense anteriorly when viewed obliquely. Its maximum density and extent is found at the onset. It clears slowly, starting at the axilla.

Diffuse childhood type tuberculous infiltration occurs as spots, strands or both, denser toward the pleura in tangential views. Indolent lesions are strand-like and recur unilaterally. Progressive lesions show confluent spots

Fig. 3. Tuberculous consolidation, progressive, excavating. (Children's Orthopedic Hospital, Seattle).

which may develop into tuberculous consolidation, progressive and unstable (4).

From these descriptions it will be quite readily seen that both types of tuberculous consolidation resemble lobar pneumonia in X-ray appearance, and diffuse childhood type tuberculous infiltration resembles bronchopneumonia. To facilitate description and make comparisons readily let us place these three types of parenchymal lesions in one group under the old classification of tuberculous pneumonia.

We should not minimize the value of classification according to tissue changes, that is, whether they are parenchymal, glandular, or otherwise, but the question which is most fundamental and most important of all whenever we discover pulmonary lesions is this: Are they tuberculous or non-tuberculous? This point cannot be overemphasized. There are no typical X-ray features differentiating tuberculous from non-tuberculous pneumonia. The X-ray findings in both conditions are the same, and other diagnostic aids must be used in making a differential diagnosis. In this, clinical history frequently takes a major part. We are at times confronted with X-ray plates demonstrating shadows which may be tuberculous or non-tuberculous pneumonia. In making a differential diagnosis let these simple, important questions be asked:

1. How long has the patient been sick?
2. How sick is he?
3. If he has fever, what is the type of the fever?
4. Has he been in intimate contact with an adult person ill with tuberculosis?
5. Is the Mantoux test positive?

Keeping in mind the first two questions relative to the length of illness and its severity, we are guided in making conclusions by these facts: In non-tuberculous pneumonia the onset is abrupt, the patient is acutely ill, and the duration of the illness is short. In tuberculous pneumonia the onset is usually gradual, with certain exceptions the patient is not acutely ill, and the illness persists over a considerable length of time, and, let us add, the X-ray lesions are persistent.

When tuberculous pneumonia occurs in children under two years of age or, in fact, in older children in which tuberculous pneumonia is the result of a primary infection, the clinical differentiation is not so definite. No immunity to the disease has been acquired and the symptoms are acute.

Let us now consider the third question. The type of fever, whether it be slightly elevated and intermittent as occurs in tuberculous pneumonia, or high and constant as is found in non-tuberculous pneumonia, gives information of decided diagnostic value.

Relative to the fourth question there is this to be said. A history of exposure to infection is valuable. If an adult member of the family or an intimate friend of the family is ill of tuberculosis, the children of that family sooner or later become infected and active pulmonary disease is found in a large number living in such an environment.

Such a history may furnish information leading to a differential diagnosis.

A word must be said regarding the Mantoux skin test. Authorities are agreed that a positive test is, in the early years of life, suggestive or conclusive of the existence of tuberculosis. After two years of age a positive reaction is not so valuable, but a negative test definitely excludes the existence of tuberculosis and we who interpret roentgenograms should recognize that if pulmonary lesions are seen they should be classified as non-tuberculous or healed tuberculous lesions when the skin test is negative. Miliary tuberculosis offers an exception, as the Mantoux test is sometimes negative in this serious form of tuberculosis.

The lesions of miliary tuberculosis are also parenchymatous in type. They occur as "universally distributed soft mottled shadows in both lungs," and the X-ray findings are so characteristic that a direct diagnosis can be made from them alone. For this reason differential diagnosis is not being considered.

Again quoting from McPhedran's outline:

The X-ray appearance of uncalcified tracheobronchial lymph nodes is depicted upon radiograms as large convex masses projecting into the parenchyma from the mediastinum or hilus, or from both. . . . . Calcified tracheobronchial lesions are demonstrated as granular, stippled, or irregular dense shadows.

Calcified lesions are characteristic of the existence or previous existence of pulmonary tuberculosis and offer no great problem in differential diagnosis.

Uncalcified lesions, on the other hand, are not dismissed so easily. There are many etiological factors other than tuberculosis causing enlargement of tracheobronchial glands and a clinical history and other diagnostic aids must be resorted to in making

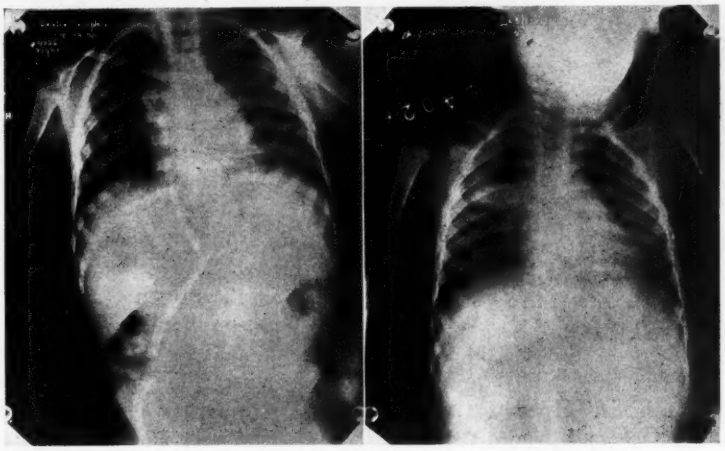

Fig 4-*A* Fig. 4-*B*

Figs. 4-*A* and 4-*B*. Tracheobronchial lesions, uncalcified.
How long sick?—Confined in hospital five months. Sick several months before entry.
How sick?—Not acutely ill.
Temperature?—Intermittent fever, rarely above 100 degrees, but frequently that high in afternoon.
Contact?—Father died of tuberculosis. Positive Mantoux. First, X-ray findings of enlarged tracheobronchial glands; later, parenchymal lesion. Primary focal lesion not found. Patient has been troubled with phlyctenular conjunctivitis, a complication of tuberculosis.
L. S. male; age, 2 years (Children's Orthopedic Hospital, Seattle).

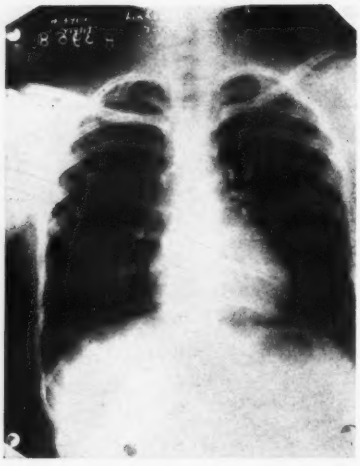

Fig. 5. Tracheobronchial lesions, calcified. (Children's Orthopedic Hospital, Seattle).

a differential diagnosis. History of recent existence of some acute infectious disease, post-nasal infection or other respiratory or mediastinal diseases must be considered. X-ray findings of glandular enlargement do not have any distinguishing roentgen features, and it is only when they are seen to be caseous or calcareous that they can be definitely classified as tuberculous from an X-ray standpoint alone.

We will now consider lesions of adolescence. These are described by McPhedran as "spots, or spots and strands, or wedges, or irregular masses based on apical pleura often most easily demonstrable below the third or fourth rib posteriorly." (In other words, in a subapical region.)

Differential diagnosis in pulmonary tuberculosis of the adolescent is practically identical with tuberculosis of the adult and should be approached in the same manner. Answers should be gotten to the clinical questions which are stressed in this paper and every diagnostic aid should be employed.

Myers, of the University of Minnesota, gives an excellent description of this type of pulmonary tuberculosis in his recent publication "Tuberculosis among Children" (3). I quote briefly:

About the time the twelfth year of life is past, the tuberculosis scene changes. In the background one sees the childhood type of tuberculosis, sometimes in calcified form (calcified tracheobronchial glands or calcified focal tuberculosis); again in the form of recent inflammatory processes in the lung parenchyma (parenchymal lesions). Any boy or girl who has not been previously infected so as to develop pulmonary disease will suffer from the childhood type as would an infant of six months. The adult type is the destructive type that takes such a toll in human life through the teen ages. It never develops except in the presence of previous infection with tubercle bacilli which has resulted in some immunity. The disease usually begins in the region of the apex of one or both lungs. There is a strong tendency toward fibrosis, since the disease is of a chronic nature. The regional lymph nodes do not show the same changes as they do in the childhood type of tuberculosis. There may be some enlargement at the lung hilus but at the postmortem table caseous and calcified nodes usually are not seen unless they are remnants of the old childhood type and are quite independent of the new adult type of tuberculosis.

And here he makes a significant statement.

Recent X-ray studies have shown that such lesions (that is, lesions of adolescence) often are present months, and even years, before they result in symptoms of tuberculosis. Even the physical examination may be entirely negative while the lesions are undergoing development. Disease of quite advanced stage is not uncommon in a girl or boy in the teen ages who appears normal, perhaps is overweight, or even one who is engaged in major athletic activities.

Are not these statements of Myers interesting and instructive? They indicate how insidious and treacherous pulmonary tuberculosis may be when it occurs in the adolescent child. They warn us of the neces-

sity of making X-ray examinations of the chest when there are persistent or recurring symptoms, even though they may be slight.

SUMMARY

Physical and X-ray examinations of chest diseases are rarely sufficient in themselves. Other diagnostic aids must be used in making a differential diagnosis.

When lesions are seen in an X-ray examination of the chest it is very important to determine whether these lesions be tuberculous or non-tuberculous.

In differentiating between tuberculous and non-tuberculous pulmonary disease, the following questions are important: (1) How long has the patient been sick? (2) How sick is he? (3) What is the type of fever? (4) Has the patient come in contact with tuberculosis? (5) Is the Mantoux test positive?

McPhedran's classification of tuberculous pulmonary lesions in children is very valuable.

In discussing parenchymal lesions of adolescence, Myers is quoted as saying: "Recent X-ray studies have shown that such lesions often are present months and even years before they result in symptoms of tuberculosis."

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CASE REPORTS AND NEW DEVICES

A PRACTICAL RADIUM PACK FOR BEDSIDE USE

By IRA I. KAPLAN, B.S., M.D., Director, Division of Cancer, Department of Hospitals, New York City; Attending Radiation Therapist, Bellevue Hospital; Professor Clinical Surgery, New York University and Bellevue Medical College, NEW YORK CITY

In the large general hospital where cancer cases of every type and in all stages of the disease are admitted to the radiation service, it is essential that there be some flexible method of administering the radiation to those patients who must receive treatments while confined in a hospital bed. In such cases, in which the local lesion to be treated is small and in which intratumoral or small surface applicators can be employed, there is, of course, very little difficulty in carrying out the prescribed therapy. However, in those cases in which massive doses of radiation have to be given, then, either the high voltage X-rays or the large radium pack must be used. Obviously it is impossible for physical reasons to move a high voltage X-ray apparatus to a patient's bedside. Similarly, the ordinary radium pack, as constructed in the various clinics here and abroad, is a stationary contrivance installed in a special room to which the patient must be transported.

As is well known, the cancer patient is usually apprehensive of the treatment given him and fearful of being confined in a room alone with the mysterious radiation forces he has been advised to allow to have administered. He dreads the idea of leaving those around him, and in one sense he exemplifies the truth of the old adage that "misery loves company."

It seemed to us, therefore, quite worthwhile and feasible to construct an apparatus which we could transport to the patient and which would permit of the application of a large amount of radium radiation to him, or to the lesion requiring it, while he was in his bed among his fellow-patients. This would enable him to carry on his normal mental existence; eat, drink, and sleep in an unfrightened atmosphere under the supervision of the regular ward nurses and physicians.

From the therapist's standpoint it was necessary to have this portable radiation apparatus so made as to be flexible and easily adaptable to all positions and all locations of lesions, be readily movable, and adjustable to the hospital bed. This portable pack must also be large enough to carry a gram or more of radium in such manner as to allow for the emission of a maximum amount of gamma radiation in a desired direction to the part to be treated, while at the same time protecting both the patient and his attendant as well as neighboring patients from scattered radiation.

In designing any portable radium pack, several problems had to be considered: (1) The radiant source must be encased in a well-protected lead box. On account of the large amount of lead used in its manufacture, this lead-shielded radium container is very heavy, and, therefore, any stand made to carry it must necessarily be heavy enough to prevent tilting. (2) In order to reach over a patient in bed there is needed a long extension arm on which the radium container can be hung.

To meet these requirements, a large, heavy, iron base was constructed, capable of withstanding a tilting strain of 3,000 pounds. To this base are attached three tubular uprights on which the mechanism for raising, lowering, and moving the cross-arm is con-

nected. The base rests on ball-bearing castors for easy rolling.

The cross-arm is long enough to extend the fork on its center of gravity on two side prongs of the fork holder. This entire arrangement makes for complete universal

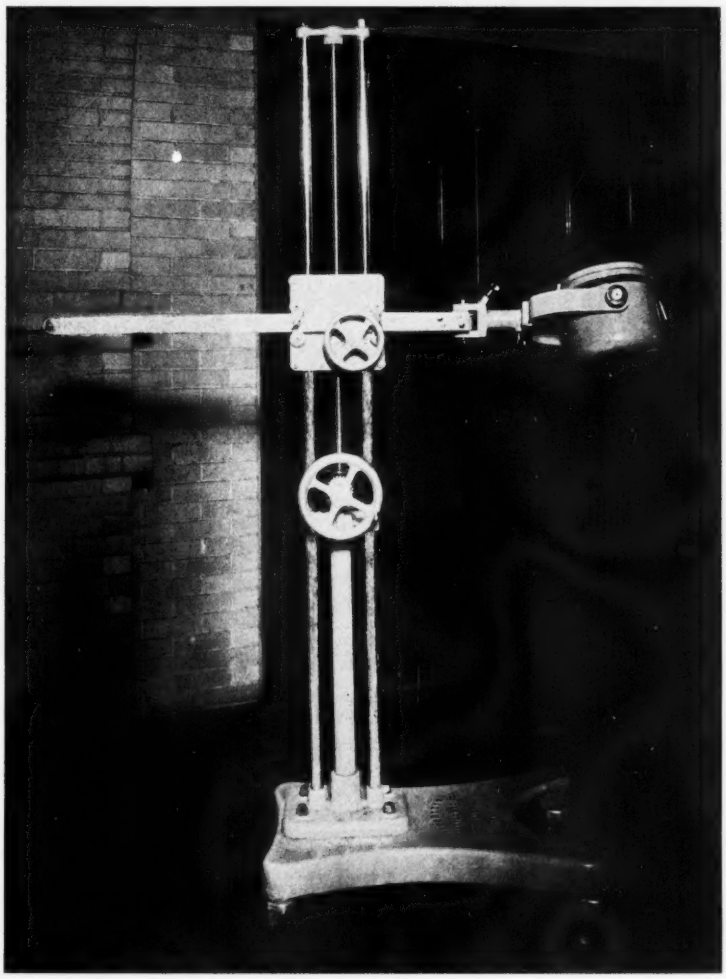

Fig. 1. A practical radium pack for bedside use.

83 centimeters (32 inches) over a bed, and at its end, attached by a hinged joint, is a steel fork which supports the radium shield. The prongs of the fork are welded together into a swivel-locked socket joint attached to the stem, which is hinged to the cross-arm. The radium container is suspended in movement such as is necessary in the adjustment of the radium applicator to the surface requiring treatment.

The radium container is a cylindrical box of lead weighing 120 pounds, encased in a copper jacket, one millimeter thick, over which is a laminated, turned wooden shell

22 millimeters thick snugly fitted over the copper. The lead box is lined with a one-millimeter layer of copper. The lead shield is 32 millimeters thick and the overall diameter of the lead is 19 centimeters. The inside diameter of the cylindrical cavity of the box is 12½ centimeters. The height of the cylinder is 25 centimeters. The top is made of a wood-covered leaden lid hinged to one side and with a hasp on the other for locking with a padlock. The base of the box has a diaphragm opening 10 centimeters square, and is thus constructed so that various sizes of lead blocks with wood cones of different sized diaphragms may be attached to the outside to vary, as desired, the distance from the radiant energy source. Space is left between the base and the cones for the various types of filters it may be desirable to use.

The cross-arm moves up and down by means of a long screw driven by an iron gear arrangement, which is mounted on Timken roller bearings, while the horizontal movement of the cross-arm is effected by means of a rack and pinion gear. Ball bearings reduce friction to a minimum. The various arrangements of gears allow for precision settings of the cross-arm.

Complete, the whole stand weighs about 550 pounds, but, because of the roller-bearing castors, can be easily pushed about the ward. With the assistance of Mr. Stoyer, of the Peerless Electro-medical Corporation, the portable pack herewith illustrated (Fig. 1) was constructed.

MIGRATING COLON[1]

CASE REPORT

By C. E. PIERSALL, M.D., F.A.C.R.,
RENO, NEVADA

On October 18, 1930, C. W. W., a male physician, aged 53 years, weighing 190 pounds, was referred to me for roentgen examination of the colon because of frequent bloody stools and early appearance of cachexia.

A barium enema was seen to traverse a large loop or redundancy located just above the middle portion of the descending colon. The entire descending colon and splenic flexure were irritable and quite spastic, having the appearance of spastic colitis. The transverse colon filled to about its middle portion; this filled part descended alongside the splenic area. There was no pinching off of the barium column that would suggest obstruction. The patient could not retain enough to fill the first half of the colon. Several examinations followed meals at different intervals and no deviation from normal in size, shape, position, or outline was seen in the first two-thirds of the colon. Each day the spasticity of the descending colon decreased.

On December 17, 1930, at six hours *post cibum* the barium meal was found in the terminal ileum and the entire colon. The cecum, ascending colon, and the first half of the transverse colon were to the left of the midline. The cecum was located just to the left of the midline in the pelvis (Fig. 1). At twenty-four hours *p.c.* the colon was in normal position, freely movable, and the descending colon was more regularly and normally haustrated than in October (Fig. 2).

The personal history suggests that the attachment of the hepatic flexure may have been loosened by trauma, although a congenital anomaly may account for the hypermobility. At the age of 10 years, the patient fell off a coaster, striking the abdomen on the end of the sled. At the age of 14 years, he fell eight feet off a high bicycle, striking the abdomen on a large rock. At

[1]This case was reported at the staff meeting of St. Mary's Hospital, Reno, Nevada, Jan. 5, 1931.

Fig. 1. Film made six hours after the ingestion of food.

Fig. 2. Film made twenty-four hours after the ingestion of food: normal position.

the age of 25 years he was thrown off a cliff forty feet high, and then slid eight feet, striking against a rock.

The unusual mobility of the colon is probably not related to the colitis and was a coincidental finding.

TWO CASES OF CARCINOMA OF THE EPICARDIA

By A. R. BLOOM, M.D., Detroit, Michigan

Carcinoma of the epicardia (sub-diaphragmatic portion of the esophagus) is not rare, but the following two cases are reported because each presents an interesting feature from the roentgenologic and pathologic aspects.

Case 1. Mr. S. R., aged 50, was referred to me by Dr. P. H. Broudo on May 22, 1929, for gastro-intestinal roentgen-ray study. The patient complained that since January, 1929, he had been experiencing a sensation of pressure of the epigastrium after meals, together with burning and aching at this point. He also stated that he had pain at the angle of the scapula, pain in the lower spine, pain in the rectum, and burning on urination. He had lost some weight, was constipated, and coughed. He had worked until six weeks prior to this examination. The past history disclosed that he had had malaria several years before. The family history was of no importance.

Physical examination revealed a well nourished, well built male, presenting no evidence of acute illness or cachexia. The heart and lungs were normal. There was tenderness over the cecum, hepatic flexure, and sigmoid. The spleen and kidney were not palpable. The prostate was large and

soft. The blood pressure, temperature, pulse rate, blood count, and urinalysis were normal. Dental, ear, nose, and throat examinations showed normal conditions.

On fluoroscopy the chest appeared normal. The esophagus was normal up to the point of entrance to the stomach. At this site a filling defect was seen (Fig. 1), and the patient stated that he experienced pain in this region. The stomach and cap otherwise were normal. At two hours the defect was still noted. The colon was normal.

Fig. 1. Case 1. *(A)* Defect at epicardia outlined, seen immediately after the barium meal; *(B)* film taken two hours after the meal, patient in semi-lateral position: niche still filled.

Repeating the examination in the presence of Dr. Broudo, the same defect was noted. Films confirmed the fluoroscopic findings. A film of the spine showed a hypertrophic arthritis. A diagnosis of ulcer of the epicardia, with the possibility of its being malignant, was made.

On April 2, 1929, the patient had gone to a nationally known clinic. The gastro-intestinal X-ray examination was repeated three times, but nothing was noted. Gastric analysis was negative on two occasions except for a little fresh blood in the second analysis. The patient was then esophagoscoped under local anesthesia and there was noted a little narrowing of the middle, but no ulcerative lesion. The mucosa on the gastric side of the cardia appeared a little more smooth than normal, and there was a trace of blood. Several consultants saw the patient but were unable to arrive at any conclusion. On April 19, 1929, he left the clinic.

On September 12, 1929, the case was seen by Dr. C. D. Brooks, of Detroit. At this time the X-ray examination showed an irregularity of the posterior wall of the esophagus which was very suggestive of an organic lesion, probably a carcinoma of the lower end of the esophagus. On September 28, 1929, the case was subjected to an esophagoscopic examination by Dr. Walter

Anderson, who reported a marked thickening and hypertrophy of the mucosa of the sub-diaphragmatic portion of the esophagus on the right side. No ulceration or fungoid growth was seen, but the area bled very easily.

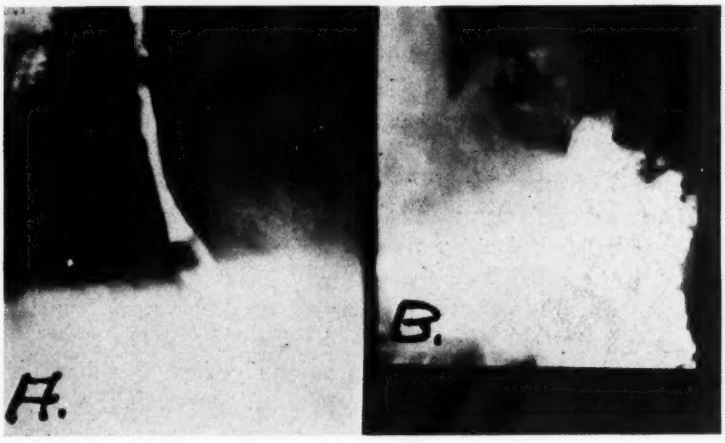

Fig. 2. Case 2. *(A)* Filling defect above the diaphragm; *(B)* large filling defect below the cardia: gas-filled cardia can be seen behind the defect.

On September 30, 1929, an exploratory operation was done by Dr. Brooks. A large mass was found in the lesser curvature at the cardiac end of the stomach. A definite crater could be felt. (It is possible that this crater was of the epicardia rather than of the stomach.) The case is interesting because of the early diagnosis by X-ray. This carcinoma was evidently of the ulcerating type.

Case 2. Mr. I. N., aged 64, was referred for gastro-intestinal X-ray study by Dr. S. G. Meyers, of the Gastro-intestinal Division of the North End Clinic, July 16, 1930. For two months prior to this examination the patient had complained of a burning sensation in the mid-sternum at the level of the third rib. The burning would last two or three minutes after the taking of food, and was brought on by eating potatoes, oranges, musk melon, buttermilk, or soup. It also followed the ingestion of bread, but would disappear if the patient drank water immediately after. In addition, he complained of belching, poor appetite, and constipation. He thought that he had lost some weight.

The past history revealed that the patient had been constipated seventeen years before the present examination. He had had an operation several years previously, the nature of which was not determined. He also had had some bladder trouble and on several occasions it had been necessary for him to be catheterized. The family history was of no importance.

Physical examination showed a poorly nourished male weighing 142 pounds. The eyes, ears, nose, and teeth were normal. There were a few persistent râles above the left clavicle which remained after coughing. The left heart border was 9 centimeters. The aortic second sound was accentuated over the entire precordia. There was

sclerosis of the peripheral vessels. No murmurs. The blood pressure was 145/90. The urine was negative and the blood count was normal. The abdomen showed a scar from a previous operation. The prostate was slightly enlarged, smooth, and not tender.

X-ray examination of the chest showed the left apex to be clear: right apex cloudy. There was evidence of Ghon's nodule in the right lung field. The heart and trachea were normal.

X-ray examination of the esophagus showed the fluid barium meal to pass readily until it reached the cardiac end above the diaphragm, where it hesitated and then passed on to the entrance to the stomach and spread out in a fan-like manner (Fig. 2), presenting large negative shadows as if the barium were going around masses. Thick barium paste hesitated a little longer. A small negative shadow was seen above the diaphragm. There was slight dilatation at the epicardia. A No. 5 barium-filled capsule was then given the patient. About two inches above the diaphragm, at the site of the negative shadow noted above, the capsule deviated anteriorly, then down, and posteriorly. It remained fixed at the entrance to the stomach for a considerable length of time, regardless of how much fluid or thick barium paste was given. The stomach and cap were normal, except as noted above. The colon was negative except that it was still filled with barium seventy-two hours later, in spite of the patient having taken a cleansing enema contrary to orders. A barium enema showed a normal contour. Films of the esophagus showed the capsule in the epicardia, still present a half-hour later. After a barium meal there was a smooth filling defect about the size of a navy bean two inches above the diaphragm and on the posterior wall. Below the diaphragm there was a large irregular filling defect which gave the impression of a large pedunculated mass on the right side. The diagnosis was two masses in the esophagus, one above the diaphragm and one below it, probably malignant.

On July 18, 1930, the patient was esophagoscoped by Dr. W. Hudson, of the Chest Division of the North End Clinic. Just above the cardia a nodular mass covered with intact mucosa and with a smooth surface of reddish color was encountered, which was rather firm in consistency. A specimen was taken for microscopic study and marked "upper specimen." As the esophagoscope entered the cardia, ragged mucosa (vascular and fragile) was encountered. This mass was so large that it completely filled the space, rendering difficult a determination of its extent, but the impression given was that it was lateral to the cardia. A section here was also removed and marked "lower specimen." A diagnosis of carcinoma of the esophagus was made. Because of the age of the patient, Dr. Hudson was reluctant to diagnose a benign lesion.

Pathologic examination made by Dr. Plinn Morse was as follows:

Upper Specimen.—Specimen contains hypertrophied squamous epithelial cells. There is no evidence of malignancy.

Lower Specimen.—Specimen consists of a fragment of hyperplastic squamous epithelium, with underlying connective tissue and non-striped muscle bundles, also inspissated blood clot. There is also a fragment of rapidly proliferating carcinoma of small-cell type, probably primary carcinoma of the esophagus.

The patient was under the care of Dr. S. S. Altshuler, who reported that after the bronchoscopic examination the man never had a return of the symptoms of pain on swallowing, but that there was a gradual progressive weakness, with a lack of appetite, and a feeling of nausea at the sight of food. The stools were frequently tarry.

The liver became progressively larger, firm, and irregular, and the patient complained of pain over the liver region. Later there was an enlarged gland above the left clavicle which was firm and fixed. The weakness became more marked and the man developed a terminal bronchopneumonia and died October 17, 1930, six months after the onset of symptoms.

This case is interesting because of the peculiar appearance of the X-ray film, the presence of a probably benign lesion associated with a malignant lesion, and the rapid growth.

Colorado Sunshine. Editorial. Jour. Am. Med. Assn., March 28, 1931, XCVI, 1088, 1089.

So much is said nowadays about the dearth of sunshine and the consequent detriment to human wellbeing that it is interesting to discover some of the regions where nature's beneficent sun rays are always available in abundance. The existence of seasonal variations and their effects on the incidence of infantile rickets have been repeatedly stressed in recent years.

Tisdall and Brown found the antirachitic effect of sunshine in Toronto in April and May to be approximately eight times as great as in December, January, and February.

Day recently reported a seasonal variation in the antirachitic potency of Arkansas sunshine. According to Hess, in the tropics. rickets is almost unknown. It will be found that the intensity of rickets throughout the world corresponds in fair proportion to the amount of sunshine. Bearing in mind the varying diet of the peoples in the different parts of the world, the dominance of sunlight in the etiology of rickets is most striking. Where the women of India are deprived of the benefit of the tropical sunshine by observing the system of purdah (screening), rickets, osteomalacia, and tetany develop. Hess has pointed out that the dominant factor in regard to the antirachitic activity of the solar rays is not so much the number of hours of sunshine as its quality and intensity.

Lewis and his co-workers believe that the relative freedom of the atmosphere from moisture and smoke offers a satisfactory explanation of the comparatively high antirachitic potency of Colorado sunshine. There is no great difference in the antirachitic effect of winter and of summer sunshine in Colorado.

The law of "the vital importance of the minimum" applies to the radiations of the sun —those rays which are furnished in smallest amount and in least intensity are nevertheless most indispensable.

CHARLES G. SUTHERLAND, M.D.

EDITORIAL

LEON J. MENVILLE, M.D. . . . *Editor*

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URINARY TRACT VISUALIZATION[1]

Roentgenologic visualization of the urinary tract after intravenous injection of chemical substances has now been carried on sufficiently long to permit of its fairly accurate evaluation.

Sodium 2-oxo-5-iodo-pyridine-N-acetate, also designated as sodium 5-iodo-2-pyridon-N-acetate (uroselectan), the chemical first introduced for this purpose, like a pioneer in any field, is capable of much improvement, both from the standpoint of roentgenologic visualization and also from that of frequency of distressing reactions after administration. Reactions, it might be added, never have resulted in alarming sequels and always have been transitory. Improvements both in visualization and in diminution of reaction already have been obtained by the use of a preparation soon to be placed on the market. This preparation has a simpler chemical formula; nevertheless, it results in a much higher concentration of iodine in the urine, although less than half the dose employed with uroselectan is required.

Improvement in the preparations employed doubtless will continue, although the indications for their intravenous administration will remain approximately the same. It is apparent that any chemical given through the blood stream, because of its necessary dilution, cannot result in as satisfactory or as dense a shadow as the same chemical injected through a ureteral catheter. Therefore, unless there is some contra-indication to cystoscopic examination or unless catheterization of the ureters proves impossible, better pyelograms will be obtained by injection of the substances through catheters than by their injection into the blood stream.

In diagnosis of the presence of renal or ureteral stones, in cases in which renal function is known to be normal, and marked infection has not occurred, the position of the stone can be determined definitely by employment of urography after intravenous injection of these opaque substances. In such cases retrograde urography would not give additional information. On the other hand, if urinary infection is known to be present, the intravenous method may fail to demonstrate the situation of the infection, and since catheterization of the ureters is necessary to obtain this information, pyelograms by injection through these catheters afford more accurate data.

In cases in which tumors of the kidney, or early tuberculosis, are suspected, intravenous injection as a rule does not result in a sufficiently clear roentgenographic outline to make diagnosis possible, except in very advanced cases. However, in advanced tuberculous disease, cystitis may be so extreme as to prevent ureteral catheterization. In such cases, roentgenograms after intravenous injection may be of considerable aid, even if they are not entirely definite.

When there is urinary obstruction of any kind, such as that seen in hydronephrosis or hydro-ureter, intravenous administration gives very satisfactory results. The opaque substance, by being retained, causes in-

[1]Submitted for publication November 18, 1930.

creased density of the renal shadow and the hydronephrotic process is outlined. This fact of increased density in cases of urinary obstruction interferes with the value of these preparations as determinants of renal function by roentgenologic methods. For instance, if secretion is rapid and obstruction does not occur, sufficient opaque substance may not be retained in the renal pelves and calices for them to be outlined satisfactorily, and it may be assumed that the kidneys have been unable to excrete the substance. On the other hand, if function is impaired by obstruction, the opaque substance may be retained in the renal pelvis and the inference may be that renal function is good.

It would seem, therefore, that urography after intravenous injection of opaque substances will establish itself as an adjunct to cystoscopy and retrograde urography. It probably will be employed in the occasional case in which cystoscopy or retrograde urography is unnecessary, but chiefly in cases in which extreme irritability, advanced inflammation, or anatomic position makes catheterization of the ureters impossible.

HERMON C. BUMPUS, JR., M.D.

ANNOUNCEMENTS

SECTION ON RADIOLOGY, WISCONSIN STATE MEDICAL SOCIETY

The Seventh Annual Meeting of the Section on Radiology of the Wisconsin State Medical Society was held in Milwaukee on May 27, 28, and 29, under the Chairmanship of James A. Evans, M.D., of La Crosse. Frank W. Mackoy, M.D., of the Sacred Heart Sanatorium, Milwaukee, served as Secretary-Treasurer, and the members of the Executive Committee were, besides Dr. Mackoy, R. P. Potter, M.D., of Marshfield, and J. C. Baird, M.D., of Eau Claire.

The program presented much of value, and attracted radiologists from beyond the limits of the State. M. J. Hubeny, M.D., of Chicago, was Toastmaster at the banquet, the address of the evening being presented by Joseph C. Bloodgood, M.D., of Johns Hopkins University and Hospital, Baltimore. B. R. Kirklin, M.D., attended from the Mayo Clinic, E. L. Jenkinson, M.D., and James T. Case, M.D., from Chicago, and Leo G. Rigler, M.D., from Minneapolis.

ILLINOIS RADIOLOGICAL SOCIETY

At the April, 1931, meeting of the Central Illinois Radiological Society, held at Peoria, Illinois, the Society voted to change its name to the Illinois Radiological Society, in order to indicate more correctly the scope of its membership. This Society was largely organized by a group of radiologists from Central Illinois in 1920, but has steadily grown and for years has had members from every section of the State.

The Illinois Radiological Society is one of the oldest state radiological societies in the West.

The officers of the Society for 1931 are C. E. Morgan, M.D., of Mattoon, *President*, and Fauntleroy Flinn, M.D., 220 South Webster Street, Decatur, *Secretary-Treasurer*.

MINNESOTA RADIOLOGICAL SOCIETY

The annual meeting of the Minnesota Radiological Society was held in Minneapolis, May 4, 1931. The following program was presented:

ROUND TABLE DISCUSSIONS

1. Therapeutic X-ray Dosage and Measurement Problems. Conducted by E. T. LEDDY, M.D., Rochester.

2. Gastric Ulcer. Conducted by J. RICHARDS AURELIUS, M.D., St. Paul.
3. Traumatic Spine Lesions. Conducted by GAGE CLEMENT, M.D., Duluth.
4. The Chest in Children. Conducted by MALCOLM B. HANSON, M.D., Minneapolis.

Informal Dinner.

ADDRESSES

The Intervertebral Disc. By EMIL S. GEIST, M.D., Minneapolis.

Pathologic and Roentgenologic Study of Joint Diseases. By R. K. GHORMLEY, M.D., Rochester.

The present officers were re-elected for the coming year as follows: B. R. Kirklin, M.D., Rochester, *President;* Gage Clement, M.D., Duluth, *Vice-president;* Leo G. Rigler, M.D., Minneapolis, *Secretary-Treasurer.*

POST-GRADUATE LECTURES IN FRANCE

Post-graduate lectures on biological problems and therapeutics concerning cancer (with practical demonstrations).—This course will be held from July 20 to 26, 1931, under the supervision of Prof. G. Roussy, with the collaboration of his staff, Prof. Huguenin, Prof. Leroux, Prof. Oberling, Prof. Verner, Prof. Sannié, Associate Prof. Mme. le Dr. Laborde, Dr. Chastenet de Géry, Dr. Y.-L. Wickham, and Dr. Bertillon.

Lectures will be delivered every day from 10 A. M. to 12 N., at the Institut du Cancer de la Faculté de Médecine de Paris, on the following subjects:

I.—Survey of the present status of the biological problem of cancer.

II.—Treatment of cancer by combination of radiation and surgery: statistics of results, with special reference to breast, uterus, skin, and thyroid.

III.—New facts about experimental cancer.

IV.—Culture of tissues in cancer study.

V.—Chemistry and chemical treatment of cancer.

VI.—Prognosis based on histologic study of cancer.

VII.—Social service for cancer, and anticancerous armamentarium in France.

Fee: 500 francs ($20).

Lessons in Clinical Radiology (with lantern slides).—Demonstration of the principal and newest technics. By Associate Professor R. Ledoux-Lebard and Dr. Belot and Dr. Maingot. Hospice de la Salpêtrière, 47 Boulevard de l'Hôpital, Service of Clinical Radiology, Medical Faculty of Paris, July 20 to 26, 3 to 6 P. M.

The titles of the Lessons are as follows: (1) Roentgen exploration of the mucosa; (2) Ulcers of the digestive system; (3) Roentgen diagnosis of the urinary tract; (4) Roentgen diagnosis of genital conditions; (5) Superficial roentgenotherapy; (6) Results of deep roentgenotherapy.

Fee: 500 francs ($20).

Lectures on Medical Electrology (with practical and clinical demonstrations).—By Dr. Bourguignon, Dr. Delherm, and Dr. Laquerrière, electroradiologists of the hospitals of Paris, collaborating with Dr. Vignal and Dr. Morel-Kahn, Senior Assistants. July 6 to 11, 1931, 10 A. M. to 2:30 P. M., Hôpital de la Pitié, 83 Boulevard de l'Hôpital, Paris (13). (Métro, Saint-Marcel.)

The lectures are on the following subjects:

I.—General points on the technic of electrodiagnosis (classical electrodiagnosis, chronaximetry).

II.—Relations between clinical conditions

and the information derived from electrodiagnosis.

III.—Chronaxia, its technic and its contribution to physiology: chronaxia in pathology.

IV.—The galvanic current and its trophic action: ionization.

V.—Electricity as an agent in gymnastics and in the treatment of muscular atrophy and neuritis; the Bergonié method: alternating waves of long periods.

VI.—Ionotherapy in the treatment of infantile paralysis, cerebrospinal affections, neuritis, and neuralgia.

Fee: 500 francs ($20).

A certificate signed by the professor in charge or the lecturers will be given after the course to every doctor who has attended regularly.

For further information and for registration apply to the Association pour le Développement des Relations Médicales, Salle Béclard, Faculté de Médecine, Paris (6).

Occupational Neoplastic Disease. Cushman D. Haagensen. Am. Jour. Cancer, April, 1931, XV, 641-703.

The author reviews the literature of occupational cancer, and gives statistics of his own collected from the Memorial Hospital. In this study, he discusses (1) the occupational distribution of certain types of neoplastic disease; (2) their occupational incidence; (3) the anatomic distribution of the cancers in the occupational groups, and (4) the average ages at which the tumors occurred in the different occupational groups.

Of particular interest to radiologists is occupational exposure to roentgen rays and radio-active substances. Unfortunately, the details regarding the type and length of exposure to radiation, particularly of X-radiation, are meager. A total of 20 cases is listed. Of these, 11 were roentgenologists, one radium chemist, one nurse handling radium, and two painters of watch dials with luminous paint containing radium mesothorium. There were five cases following the therapeutic application of X-rays. All the cases of neoplastic disease caused by X-radiation were cutaneous cancer. In the radium group there was one case of cutaneous cancer, one case of lymphatic leukemia, and two cases of osteogenic sarcoma. The latter occurred in the watch dial painters. The average time interval between the first exposure and the appearance of carcinoma amongst the roentgenologists was fifteen and a half years. Metastases occurred in 63 per cent of these cases and death resulted in 35 per cent. The time interval between the first exposure and development of carcinoma in the cases resulting from therapeutic radiation was eleven years.

(*Abstractor's note:*—This article should be read by all those having to do with the handling of X-ray apparatus and radium. The widespread use of the fluoroscope, for instance, introduces an additional element of hazard. What the results will be, only the future can disclose.)

JOHN R. CARTY, M.D.

ABSTRACTS OF CURRENT LITERATURE

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APPARATUS

An Improvement in Grenz-ray Tubes. O. Glasser and I. Beasley. Strahlentherapie, 1931, XL, 389.

This is a brief description of a tube for use on low potentials of about from 6 to 12 K.V. It has a thin glass window in place of the conventional Lindemann glass. The new arrangement permits the exposure of a larger field and also has not the disadvantage of deterioration. Further experiments and additional improvements are promised.

ERNST A. POHLE, M.D., Ph.D.

The Ångström Pyranometer, Type 1930. Anders Ångström. Strahlentherapie, 1931, XXXIX, 526.

This is a brief description of an improved pyranometer constructed by Ångström, which serves for meteorological observations.

ERNST A. POHLE, M.D., Ph.D.

Experiments with High Voltage Tubes. T. A. Fleming. Science, 1931, LXXIII, 141.

The author, who is the acting director of the Department of Research in Terrestrial Magnetism of the Carnegie Institute of Washington, gives a short description of the paper on high voltage tubes by M. A. Tuve, L. R. Hafstad, and O. Dahl, which was awarded the prize of a thousand dollars at the December, 1930, meeting of the A.A.A.S. in Cleveland.

Potentials to approximately two million volts are produced by oil-immersed Tesla coils, and applied to a specially developed sectional vacuum tube made of pyrex glass, capable of withstanding this high voltage. The reflection of the beta rays produced with these tubes in calibrated magnetic fields was measured, and showed that the fastest beta rays had speeds corresponding to the peak voltage applied to the tube, thus verifying the voltage measurements. The gamma rays from the tubes were measured through one, two, and three inches of lead, with a Geiger-Mueller tube counter. With the tube operating at about 1,300,000 volts, the penetrating power of the gamma rays was found to be the same as that of the gamma rays of radium measured under the same conditions. The tube thus produces artificial beta and gamma rays, practically covering the radium spectrum, whereby the intensity corresponds to a very large quantity of radium. These investigations, which have been developed for studies relating to atomic physics, have opened an important field for therapeutical application.

OTTO GLASSER, Ph.D.

A New and Simple Apparatus for the Production of Radium Emanation. P. M. Wolf and N. Riehl. Strahlentherapie, 1931, XL, 159.

This is a brief description of an apparatus for the production of radon, based on the principle that carbon absorbs emanation very easily. No complicated vacuum pump system is required. The principal parts are shown in illustrations.

ERNST A. POHLE, M.D., Ph.D.

ARTHRITIS

Chronic Arthritis. M. H. Axline. United States Vet. Bureau Med. Bull., April, 1931, VII, 297.

The author analyzes 974 cases of chronic arthritis occurring in 7,000 admissions seen in the past nine years. These he divides into the intra-articular or hypertrophic type, and the periarticular or atrophic variety.

Exposure to elements outdoors and to sudden changes in temperature were outstanding etiological factors. Trauma was frequently a direct cause. Dental infections, tonsillitis, and pes planus were more prevalent in the arthritic group. The association with chronic constipation was believed to be of minor importance. Headaches, glycosuria, and tuberculosis were relatively rare. Heart affections were found more frequently in the atrophic type.

The cardinal symptoms were pain, crepitus, and loss of motion. Redness, heat, swelling, and muscular atrophy were at times present in the periarticular type. While in the hypertrophic variety because of the early bone changes a positive roentgenogram was frequent, the far advanced cases of the atrophic

type very often showed no manifestations on the X-ray film.

In the treatment of these cases the author advises the clearing up of foci of infection, the correction of deformities, and the proper regulation of diet. Exercise, when carefully given in selected cases, proved beneficial. Medication consisted of arsenic and quinine used internally, and analgesic balms externally. The use of salicylates in the chronic group was discarded, and foreign protein injections were uncertain in their results. Deep therapy, ultra-violet, massage, passive motion, interrupted galvanic current, cabinet baths, and whirlpool and Scotch douches were the forms of physiotherapy employed. The author stresses the importance of adequate knowledge of the proper application of physiotherapy and a most careful selection of cases. The routine employed, which was varied at times, was as follows: For the hypertrophic type, from 20 to 30 minutes of diathermy followed by from 10 to 20 minutes of deep therapy; for the atrophic type, from 20 to 30 minutes of deep therapy followed by ultra-violet rays for from 5 to 10 minutes.

J. N. Ané, M.D.

The Etiology of Rheumatoid Arthritis. Russell L. Cecil, Edith E. Nicholls, and Wendell J. Stainsby. Am. Jour. Med. Sci., January, 1931, CLXXXI, 12.

The authors have carried out extensive experiments in an attempt to determine the etiological organism producing typical rheumatoid arthritis.

They consider the following questions:

1. Is rheumatoid arthritis an infection?
2. If rheumatoid arthritis is an infection, is it a streptococcal infection?
3. If it is a streptococcal infection, how do the streptococci gain access to the joints?

They subjected 154 cases to blood cultures, finding 96, or 62.3 per cent, yielding short-chained streptococci. In 49 cases, cultures were made from one of the affected joints, 33, or 67.3 per cent, showing short-chained streptococci. Thirty-seven out of 48 cases subjected to both blood and joint cultures showed streptococci in either the blood or the affected joint. They were able to reproduce in rabbits a rheumatoid arthritis, with typical strains of streptococci, having a striking similarity of histological changes to those in human rheumatoid joints.

The conclusions the authors have drawn from these experiments and observations would seem to indicate that rheumatoid arthritis is the result of a streptococcic infection from a focal infection elsewhere in the body.

Roe J. Maier, M.D.

BLOOD CHANGES

Contribution to the Biologic Effect of Roentgen Rays. G. Schaal, M. A. Gruschetzkaja, and E. J. Zwilichowskaja. Strahlentherapie, 1931, XL, 111.

The potassium-calcium quotient in the blood serum changes following exposure to roentgen rays. An analysis of 20 patients showed that the change is apparently dependent upon the time interval between the exposure and the blood examination. During the first few days following treatment, the potassium is increased and after that the calcium. It might be possible to explain some of the phenomena as X-ray sickness, early reaction, fluctuation of the leukocytes, and the analgesic effect of roentgen rays by this variation of the potassium-calcium ratio.

Ernst A. Pohle, M.D., Ph.D.

The Glutathion Content of the Blood in the Mountains and Following Irradiation with Mountain Sun. J. von Deschwanden. Strahlentherapie, 1931, XXXIX, 278.

Glutathion, a tripeptid, discovered by F. G. Hopkins, seems to play an important rôle in the oxygen metabolism. The author studied its behavior in rabbits following exposure to sunlight. He found that the glutathion content of the blood and of the red blood corpuscles is increased at heights of from 1,300 to 1,500 meters above the sea level. The quotient glutathion / erythrocytes is increased in these heights, which means that the glutathion content of the red blood corpuscles is also increased. Following exposure to the sun

(duration, one hour), the glutathion content of the blood decreases and also the quotient glutathion / erythrocytes. It is concluded from these observations that the specific breathing function of the blood or the red blood corpuscles is increased at heights up to about 1,500 meters above the sea level, and it is very probable that exposure to the natural mountain sun decreases it.

ERNST A. POHLE, M.D., Ph.D.

A Case of Roentgen Aleukia Cured by Extirpation of the Spleen. C. Hegler and W. Griesbach. Röntgenpraxis, Jan. 15, 1931, III, 75.

An extensive roentgen treatment for generalized psoriasis led to a very severe damage to the hematopoietic apparatus, anemia, leukopenia, absence of platelets, bleeding from the gums and retina. Eleven transfusions kept the patient alive for six weeks, but a regeneration of the bone marrow did not take place until after the removal of the spleen. This case is the only one, to the authors' knowledge, in which a severe hemorrhagic aleukia and anemia, induced by roentgen rays, has been cured by a splenectomy. The authors advise this treatment for similar cases.

H. W. HEFKE, M.D.

BONE (DIAGNOSIS)

The Clinical and Roentgenologic Manifestations of Scurvy in a Seven-year-old Child. Joyce I. Hartman and Eugene Friedman. Am. Jour. Dis. Child., February, 1931, XLI, 337.

A case of scurvy in a child of 7 years is presented to help bridge the gap in the knowledge between infantile scurvy and adult scurvy, and to show the roentgenographic differences between scurvy in the infant and that in the older child.

Roentgenograms of the left lower extremity were taken the day after the patient's admission to the hospital. The shaft of the femur and both epiphyses at the knee showed an absence of normal trabeculation of the bone, being more marked in the distal epiphysis of the femur. This epiphysis was separated and displaced laterally. There was a slight increase in the amount of calcification at the cortical border of the diaphyso-epiphyseal line, the latter being sharply defined. Both epiphyses were surrounded by delicate lines of increased calcification. The tibia and fibula also showed a lack of normal trabeculation. Six days later, the right lower extremity showed an appearance almost identical with that of the left. The upper extremities showed no change.

Three weeks after orange juice was started, the shafts of both femora were surrounded by homogeneous, wide shadows of increased calcification, which extended from the epiphyseal lines to the region of the lesser trochanters. Calcification was more marked in the left femur and the epiphyses were in good alignment. In six weeks the epiphyses appeared firmly united, but the trabeculation of bone was indistinct. Eight months later the trabeculation of bone was more distinct.

The case is thought unusual because of the age of the patient and the absence of the most typical roentgenologic changes seen in infantile scurvy, the Gerüstmarkzone and Trümmerfeldzone.

F. B. MANDEVILLE, M.D.

An Unusual Case of a False Ball and Socket Joint. B. F. Ward. United States Vet. Bureau Med. Bull., December, 1930, VI, 1075.

This is a case report of a patient who received a gunshot wound of the upper and middle thirds of the left arm, which penetrated the bone. After the bone fragments had been removed, osteomyelitis developed, but following a second operation the infection cleared up. Two and one-half years after this, roentgenograms showed evidence of union, with new bone formation and many exostoses. Subsequent roentgenograms made two and one-half years later showed that the union was not firm. The appearance was that of a false joint. Examination made eight years after the injury revealed a preternatural mobility of the left humerus at the point of fracture, with no evidence of nerve involvement. The author believed that a weak union followed the sec-

ond operation and that because of the abnormal mobility and the friction of the two fragments an anomalous joint resulted. The upper fragment assumed the characteristics of the ball because of the greater range of motion of the shoulder joint. The lower fragment, having the more stable elbow, formed the socket.

J. N. ANÉ, M.D.

BONE TUMORS (DIAGNOSIS)

The Limitations in the Demonstrability of Bone Tumors. W. Baensch. Röntgenpraxis, April 1, 1931, III, 325.

A destructive area in a bone must reach a certain size before it is visible in roentgenograms. Films taken of the tibia in a case of bone sarcoma were repeatedly negative, while on operation a rather extensive tumor was revealed. Chasin has shown that defects in the spongiosa of the vertebral bodies as large as 1 or 1.5 c.c. were not visible. The author removed as much as 0.75 c.c. of the spongiosa in the tibia without being able to detect these areas on a roentgenogram. If only a very thin sliver of the cortex is removed (0.5 mm.), this area can be shown definitely on the film. The author is of the opinion that relatively large defects in the spongiosa cannot be shown roentgenographically, while relatively small defects in the cortex are easily shown.

H. W. HEFKE, M.D.

Two Cases of Bone Tumor from Ancient Egypt. R. A. Gardner and A. L. Urquhart. British Med. Jour., Aug. 9, 1930, No. 3631, p. 211.

These cases are interesting as throwing some light on the nature of the diseases which were present among the ancient Egyptians and about which so little is known.

The first specimen, the femur of a young person, belongs to the Ptolemaic period, and, macroscopically, shows certain areas of typical bone spicule formation of osteosarcoma. A roentgenogram clinches the diagnosis by showing the typical architecture of the growth, and one can thus exclude definitely such a condition as chronic osteomyelitis, which might be suggested by the gross naked-eye appearance. For comparison, a roentgenogram of a similar osteosarcoma in a present-day hospital patient is reproduced.

The second specimen, from a grave of the pre-dynastic period, and, therefore, probably not less than 5,500 years old, is one of the earliest yet found amongst the former dwellers of the Nile valley. The tumor occurs on the left side of the mandible, and a photograph and roentgenogram of this interesting specimen are reproduced. The diagnosis of this condition cannot be definitely established, but the possibilities of a myeloid epulis, a dentigerous cyst, a simple cyst, or a fibroma should be considered; of these, the first appears to be the most probable.

WALLACE MACKENZIE, M.D.

CANCER (DIAGNOSIS)

Observations on the Metabolism of Human Mammary Carcinoma. Frank Dickens and David H. Patey. Lancet, Dec. 6, 1930, CCXIX, 1229.

The authors first refer to the metabolic studies of Warburg and his collaborators, showing that the two fundamental processes occurring in cells are respiration and glycolysis. These two processes are related by a more or less quantitative coupling, so that an increase in the value of respiration results in a corresponding diminution in the aërobic glycolysis. In most normal tissues the aërobic glycolysis is small or zero. Warburg's earlier work suggested that tumors might be classified metabolically on the basis of the relation of the respiration to the glycolysis, but the more recent work of Murphy and Hawkins, 1925, and Crabtree, 1929, has shown that this is not generally true. In addition to this, certain granulomatous overgrowths, as well as the retina and mammalian erythrocytes, are characterized by the production of a considerable amount of aërobic lactic acid. It is, therefore, clear that aërobic glycolysis is not a specific feature of tumors, and there is a present need for more experimental observations on a comparable series of tumors to see if there may

be generalizations in the relation of metabolism to the histological and clinical details.

The authors studied a series of cases of human mammary carcinoma by these methods, and the material comprised tumors of varying degrees of cellularity, differing in type and arrangement, and with different degrees and types of connective tissue response. The metabolic investigations were, therefore, combined with a histological study of the tumors. In addition to the tumor tissue, two portions of breast showing intraductal epithelial hyperplasia were examined, and one case of chronic cystic mastitis and a portion of unchanged breast tissue near the growth. The material was obtained immediately after surgical removal. As a rule, the time intervening between the removal of the specimen and the commencement of preparation of the material did not exceed from five to ten minutes, and, as a rule, the readings were begun under forty minutes from the time of removal of the tissue by the surgeon. The improved method of Warburg was used in all experiments, and, so far as possible, duplicate estimations were made. The character and arrangement of the actual carcinomatous tissue was noted, and also the degree and type of connective tissue response.

As an index of the proportion of carcinoma to connective tissues, the number of carcinoma cells in 200 standard fields of 1/40 square millimeter was counted, and an average per field thus obtained, which was known as the "carcinoma cellularity index." In the case of the connective tissues, the amount of fibroblastic and elastic tissue reaction was noted, and the degree of small round-cell infiltration. The main clinical and pathologic features of the 20 cases examined, together with the metabolic findings, are given in the tabulation. The metabolic reactions of the human mammary carcinomas correspond, on the whole, with those of animal tumors in showing a large amount of aërobic lactic acid production, but the authors point out that, whereas, with the transplantable animal tumors one is dealing with homogeneous material almost entirely composed of tumor cells, in the human material studied the issue was complicated by the varying cellularity of the different tumors. Therefore, the technical difficulties were greater in dealing with the human tumors, and the figures obtained showed a wider variation.

The authors conclude that the two chief histological factors which can be correlated with this variability are: (1) The amount of actual carcinomatous tissue present, and (2) the degree of inflammatory cell stromal reaction, but owing to the great variations in metabolism associated with these factors, it is at present impossible to attempt to correlate the clinical with the metabolic findings. It is recommended that any one studying the metabolic processes of carcinoma, especially those in the human, take into consideration the amount of round-cell infiltration present, as well as the presence or absence of proliferating fibrous tissue cells, as these both introduce complications of considerable importance.

H. J. Ullmann, M.D.

The Diagnosis of Cancer of the Larynx. Sir St. Clair Thomson. Jour. Laryngol. and Otol., January, 1931, XLVI, 31.

Tuberculosis is more often mistaken for cancer of the larynx than any other condition. The author states as follows:

"The converse mistake of diagnosing an intrinsic cancer as tuberculosis is not made so often, but it is becoming more frequent since many medical men have taken to basing their diagnosis chiefly on the X-ray film, and radiographers are so often ready to convict all mankind of tuberculosis!"

CANCER (THERAPY)

Cancer of the Larynx. Simon Jesberg. California and Western Med., April, 1931, XXXIV, 246.

This article is written to show the few cases of cancer of the larynx found in Los Angeles, as compared with the average number per 100,000 population found in other reports. Whereas statistic averages indicate from 29 to 70 cases per year, the hospital records for a ten-year period show but 18 operations for laryngeal carcinoma. Early diagnosis is stressed and the surgical treatment is outlined.

Irradiation therapy is held to be palliative and is used only in inoperable cases.

There is a lengthy discussion by Rulon S. Tillotson and Orville N. Meland.

F. B. SHELDON, M.D.

Our Clinical Experience with Cancer of the Vulva. M. Tausch. Strahlentherapie, 1931, XL, 44.

During the past twenty years, 32,415 patients were seen in the Women's Clinic of the University of Tübingen; 54 of these, or 0.17 per cent, had cancer of the vulva. In 50 patients, the tumor was primary, while in the remaining four, it was metastatic. Nine of the primary cases represented recurrences which had been treated previously elsewhere. The disease occurred mostly between the ages of 60 and 70. There was no definite relation between cancer of the vulva and leukoplakia or kraurosis. Twenty-five patients had enlarged regional glands; 11 of these were resected but only in eight cases could a histological diagnosis of cancer be made. They were mostly squamous-cell carcinoma, with cornification. Of the 41 primary cases, two left the clinic untreated. Of the remaining 39 patients, 19 were operated on, seven were operated on and irradiated, and 13 irradiated only (seven patients, X-ray only; five patients, X-ray plus radium; one patient, radium only). The technic of radiation was: Deep therapy over five areas, 1 E.D. each, at 30 cm. F.S.D.: 23.1 mg. radium element filtered through 1 mm. brass, plus 0.3 mm. Ag applied in contact for 48 hours. Of the 19 operative cases, one patient died following operation, and one could not be traced. Twelve remained under observation less than five years. One of these is alive, nine have died from cancer, and two have died from other diseases. Five patients were observed longer than five years: one is alive, three are dead from cancer, one died from another disease. Seven patients were operated on and then irradiated. Five of these were observed less than five years: four died from cancer, one from another disease. Two were observed longer than five years and both are still alive. Thirteen patients were treated by radiation; one could not be traced. Eleven were observed less than five years: two of these are still alive, and nine have died from cancer. One was observed over five years and died finally from the carcinoma.

No detailed data are given concerning the nine patients who came in with a recurrence after being treated in another clinic. Of the four secondary carcinomas, three had the primary type in the fundus, and one in the vagina. They were all treated with a combination of roentgen and radium rays. One case could not be traced, one died four and a half years after the treatment from a recurrence, two are still alive, one for a period of eight years, and the other for thirteen and a half years.

Although the author contends that his material is not sufficient from which to draw far-reaching conclusions, he is of the opinion that cancer of the vulva is very malignant and apt to recur many years after the treatment.

ERNST A. POHLE, M.D., Ph.D.

Treatment of Skin Cancer. Joseph J. Eller and Everett C. Fox. New York St. Jour. Med., Nov. 15, 1930, XXX, 1344.

Before outlining the therapeutic procedure in the treatment of cutaneous newgrowths, an effort should be made by microscopic study to determine the degree of malignancy and radiosensitivity. X-ray and radium are important agents in treating skin cancer, either singly or combined with various surgical procedures.

In basal-cell epitheliomas, the authors confirm the good results reported by MacKee, who used X-rays, and Quick, who used radium, finding them about equal in value. They use unfiltered X-rays as a rule, 2½ or 3 skin units at 100 K.V., repeating the dose, if necessary, two weeks after all reaction has subsided. Where cartilage is involved, the lesion is first removed by the high frequency knife or electrocoagulation.

In prickle-cell epitheliomas, the treatment varies with the location and character of the lesion. Early lesions on the trunk or limbs may be treated successfully by radiation alone, though it is usually best to remove them surgically or destroy them by electrocoagulation. Lip lesions are best destroyed by electrocoagu-

lation, followed by radium, and then treated with X-rays to the lymph drainage areas; this technic has given the highest percentage of cures. Lesions of the tongue, floor of the mouth, and buccal mucosa are always serious. The authors prefer interstitial irradiation with or without electrothermic methods, with external radiation to the lymph glands.

Transitional-cell epidermoid carcinomas, usually found at the base of the tongue or on the tonsil, respond readily to irradiation and should be treated by this method.

Melanomas should be widely resected by a high frequency knife at the first sign of the growth, irradiation being used only pre-operatively.

For sarcomas of the skin (primary), the best results follow a combination of surgery and radiotherapy, the radiation dose being the same as for prickle-cell carcinoma.

W. W. WATKINS, M.D.

Radiation Therapy of Carcinoma of the Respiratory Tract: Report of Cases. Orville N. Meland. California and Western Med., March, 1931, XXXIV, 165.

The author divides the respiratory tract into the upper or larynx, the middle or trachea and bronchus, and the lung proper. In carcinomas of the larynx, the consensus of opinion is that surgery is the treatment of choice in the intrinsic type. When there is involvement of the glands, the patient is referred for irradiation, although practically always the results are palliative rather than curative. There were a few five-year cures from radium alone. The causes of failure in the early lesions are given by the author as follows:

"1. The resistant type of cell that is the basis of the growth in this locality.

"2. Imperfect distribution and calculation of dosage.

"3. Relying on irradiation alone."

In carcinoma of the trachea and bronchus, the diagnosis is made by means of the bronchoscope and biopsy, but the treatment must rest largely with the radiologist, and here the use of radon implants is recommended.

Primary carcinoma of the lung is of two types, namely, the aveolar, at the periphery, and the bronchogenetic, found at the hilum. The former is highly resistant to irradiation and the latter very sensitive. All should be given irradiation therapy, however, for some which at first appeared hopeless have disappeared after thorough irradiation, but this has been of but little avail in the metastatic carcinomas of the lung.

F. B. SHELDON, M.D.

CHEST (DIAGNOSIS)

Pericarditis with Effusion. Lucy Porter Sutton. Am. Jour. Dis. Child., January, 1931, XLI, 78.

The author states as follows: "In considering the diagnosis of pericardial effusion, two facts must be kept in mind: (1) Contrary to earlier teaching, the heart does not change its position materially in the presence of effusion. The attachments are so firm, and the heart so completely fills the space between the anterior wall of the chest and the spinal column, that it is impossible for it to sink downward and backward, as was formerly assumed to be the case. Curschmann and others showed clearly that in the presence of effusion, the heart, except possibly the apex, maintains its position in relation to the anterior wall of the chest. (2) An inflamed pericardial sac is distensible far beyond the capacity of a normal pericardium."

Because of the attachments of the great vessels, and the fact that the heart lies a little more to the left than to the right side of the chest, the left pouch of the pericardium becomes more distended with fluid than does the right, and eventually the pericardium comes in contact with the posterior wall of the chest on the left. The signs thus produced range from dullness to flatness on the left side of the chest from the angle of the scapula down. Over all or part of this area there is bronchial breathing, usually intense, with bronchophony or egophony. Tactile fremitus persists, but may be diminished, and frequently there are fine râles just above the area of dullness and bronchial breathing.

The author has studied eight cases of pericarditis with effusion, and in every case a roentgen shadow, characteristic of pericardial

effusion, was found. The pulmonary fields, as shown by roentgenograms or fluoroscopy, have been clear, thus excluding the presence of pleural fluid. Fluid has been obtained by thoracentesis in the seventh or eighth space posteriorly.

The author concludes that the physical signs described by her constitute in themselves evidence of the presence of pericardial effusion, and if any doubt exists, fluoroscopy or X-ray films will clear it up.

F. B. MANDEVILLE, M.D.

Roentgenologic Observations on the Movement of Pleural Effusions. Leo G. Rigler. Am. Jour. Roentgenol. and Rad. Ther., February, 1931, XXV, 220.

In an analysis of a series of cases of fluid in the pleural space, the author has found that all transudates and most serous effusions move freely within the pleural cavity with change in position of the patient, while purulent effusions and some serous exudates fail to change position, even though the patient be inverted. He advocates the postero-anterior film, with the patient lying horizontally on the affected side, to demonstrate small effusions which, with the patient in any other position, would fail to manifest themselves.

J. E. HABBE, M.D.

Studies of Atelectasis. E. Korol. United States Vet. Bureau Med. Bull., January, 1931, VII, 10.

The author discusses the etiology, mechanism, physical signs, roentgenographic findings, and postmortem appearance of atelectasis.

Atelectasis may be caused by any interference with the normal interchange of air in the lungs. The causes mentioned included obstruction of a bronchus by a foreign body, tumor, inspissated mucus, or cicatrization of a tuberculous ulcer within or by pressure from without, such as in aneurysm of the aorta, primary malignant tumors of the hilum glands, intrathoracic Hodgkin's disease, and leukemic masses. Other conditions of etiological importance mentioned were: injury to nerves supplying respiratory muscles, severance of attachments of muscles of respiration, accumulation of fluid in the pleural cavities, circulatory disturbances, or inflammatory or degenerative diseases of the pulmonary parenchyma.

The normal negative tension in the pleural cavity is due to the relative disproportion in size between the chest and lungs. In atelectasis there occurs an increase in the negative pressure on the affected side. The intra-abdominal pressure of one atmosphere is responsible for the elevation of the diaphragm. The atmospheric pressure on the outside of the chest causes crowding of the ribs and deviation of the sternum and spine. In like manner, the pressure in the opposite pleural cavity induces the displacement of the mediastinum to the affected side. These findings are more pronounced during inspiration because at this time the chest increases in size and the collapsed lung cannot inflate to fill the affected side.

The author discusses the occurrence of bronchiectasis in atelectasis. This was believed to be due to the accumulation of secretions from lack of drainage in the obstructed portions of the bronchial tree.

The roentgenogram reveals the following: Retraction of the affected chest, with collapse of the ribs; elevation of the diaphragm on this side, deviation of the mediastinum to the affected side, and evidence of bronchiectasis. Pneumonia or pleural effusion may be simulated if the atelectatic lobe is consolidated. In pleural effusion, however, the mediastinum is deviated to the opposite side.

Case records of atelectasis with aortic aneurysm, mediastinal tumor, leukemia, Hodgkin's disease, and post-operative massive atelectasis are reported.

J. N. ANÉ, M.D.

Chylothorax: Report of Case. Roscoe G. Van Nuys. California and Western Med., April, 1931, XXXIV, 269.

The author reports a case of chylothorax, the etiology of which is not clear. The general etiology of this condition, diagnosis, and treatment are discussed. Most diagnoses may, as

in the present case, be made from the X-ray and laboratory findings.

Irradiation therapy, in this case, to the lower mediastinal area, improved the general appearance, appetite, and weight, and lessened dyspnea and the amount of fluid in the chest.

F. B. SHELDON, M.D.

Roentgen Diagnosis of Small Pleural Effusions. Leo G. Rigler. Jour. Am. Med. Assn., Jan. 10, 1931, XCVI, 104-108.

With improvement in roentgenoscopic and roentgenographic technic the early diagnosis of small pleural effusions can now be made.

By physical diagnostic methods it is almost impossible to detect small effusions. On the Continent, especially where roentgenoscopy is the method commonly used, eccentric positions of the X-ray tube with relation to the fluorescent screen have been used to obtain visualization of small effusions. This method alone is difficult and the results are frequently indefinite. The majority of observers state there is little or no shifting of pleural effusions with change in position of the thorax. Lenk's conclusions, based on roentgenoscopic observations, indicate that pleural exudates as well as transudates move freely when the patient is moved from the upright to the prone position.

Patients in whom there was evidence of pleural effusion in the usual upright or prone postero-anterior roentgenogram were roentgenographed in a variety of positions, namely, upright, prone, supine, and lying on either side. The free movement of all pleural transudates and most of the pleural exudates was definitely established. Only those cases in which there was a large amount of fibrin or numerous pleural adhesions or an exudate of the thick plastic type showed no shifting.

To produce the change in position of the fluid from the pleural sinus below the dome of the diaphragm to the lateral portion of the pleural cavity, the lateral decubitus position is most advantageous. In this position, fluid could readily be detected when it was invisible in the usual upright or reclining positions. The shadow of the interlobar fissure, due to gravitation of the free fluid into the interlobar fissure, was changed from a thin line to a dense triangular shadow, giving an added differential factor between pleural thickening and fluid.

Sante, in the discussion, stressed the practical importance of the author's work as the roentgenographing of the patient with the affected side down.

CHARLES G. SUTHERLAND, M.D.

Syphilis of the Lungs. Heinrich Hammer. Röntgenpraxis, April 1, 1931, III, 301.

Recognition of syphilis of the lungs is very difficult. A review of the literature reveals only a few cases which have been verified by autopsy. A rather fast disappearance of infiltrations after iodine medication or salvarsan treatment does not prove the presence of lung syphilis. Tuberculosis, chronic pneumonias, abscesses, tumors, and echinococci must be considered from a differential diagnostic standpoint. A localization in the midportion of the chest and the absence of calcification are of some value for the diagnosis.

Two cases are described, with clinical histories and roentgenologic and autopsy findings. The first case presented a compact dense shadow, extending from the right hilum into the lung, with some infiltration in the left hilum, small cavities being visible in this area. Neoplastic infiltration or syphilis was suspected. The pathologic anatomic diagnosis was gummatous lung syphilis. The second case showed an intense, homogeneous shadow over the lower half of the right lung, gradually decreasing in density toward the periphery. A tumor was suspected. The pathologic anatomic diagnosis was gummatous syphilis of the lung and liver.

H. W. HEFKE, M.D.

Pneumonoconiosis in Iron Miners. George B. Lawson, W. P. Jackson, and J. E. Gardner. Jour. Am. Med. Assn., April 4, 1931, XCVI, 1129-1131.

Lanza gave the life expectancy of a metal miner, from the time he commences hard rock mining and including one year of disability immediately preceding his death, as 9.6 years. His description of miners' phthisis is classic: the chief symptom is dyspnea on exertion,

gradual in onset, sometimes preceded by a bronchitis—more often not. As fibrosis advances, the dyspnea becomes urgent and disabling. The patients show nothing in appearance comparative to their conditions. Physical signs were inadequate, apparently, to account for the symptoms in all but the advanced cases.

A study was made of seventeen air drill operators, who had run drills from three to eight years, with little protection of any sort. After a year or so of work, slight dyspnea became apparent and was more noticeable in the early morning. This moderate dyspnea seemed not to increase appreciably for a period of from six to eight years, when there developed rather rapidly a severe dyspnea, even though the worker had been in the open during the last few years. Several men developed a severe dyspnea after they had been away from the dust in the mines as long as seven years.

The fact that such operators at the time of their retirement from years of exposure to iron and silica dust have no symptoms may have little bearing on the future progress of their disease.

Analysis of the ash in one lung showed silicon dioxide, 17.28 per cent; ferric oxide, 51.58 per cent, and phosphorus pentoxide, 19.31 per cent.

CHARLES G. SUTHERLAND, M.D.

CHEST (GENERAL)

Pathology of the Superior Mediastinum. Fanconi. Schweiz. Med. Wchnschr., March 7, 1931, LXI, 229-231.

The roentgenogram of the superior mediastinum is the result of the superposition of the sternum, thymus, large vessels, and the vertebræ, and its outline may be disturbed by variations in any of these structures. Narrowing may be due to any one of many conditions, but is particularly characteristic of transposition of the great vessels. Other congenital heart lesions may produce a widening of the superior mediastinum, but the chief cause of increased width is thymic hypertrophy.

The author discusses the clinical and roentgenologic characteristics of thymic enlargement. Another cause of widening of the superior mediastinum is mediastinitis. The significance of various lines within the mediastinal outline is then discussed in detail.

H. C. OCHSNER, M.D.

Should the X-ray Displace the Physical Examination of the Lungs? G. O. Bassett. United States Vet. Bureau Med. Bull., February, 1931, VII, 146.

This question is asked in all seriousness for it seems to be more and more the tendency, due to the rapid advance in X-ray technic during the past decade, to look for an interpretation of chest pathology in the X-ray laboratory. To-day, X-ray technic is established, and with this has come a certain positiveness of opinion from radiologists that is often accepted by clinicians.

The fault lies, the author thinks, not so much with the radiologist as with the clinician. The conservative roentgenologist, appreciating the possibility of error, has never varied from the careful "it suggests" in his report. But the clinician, following the advancements in radiology, has leaped ahead, accepting as fact the infallibility of the X-ray.

The art of interpreting the pathology of the chest by auscultation, aided by observation and manual examination, is tending, in the author's opinion, to become a lost art. Skill is difficult to acquire for it exacts careful study and continuous practice.

The author's contention is that the clinician should make the physical examination first. Having thereby obtained his own mental picture of the pathology present, he should next check the findings with the radiologist, studying the films with him. An intelligent co-operation of this sort is highly advisable.

J. N. ANÉ, M.D.

Wheezing Respiration in Children: Bronchoscopic Observations on Stridorous and Asthmatoid Breathing. Chevalier Jackson. Am. Jour. Dis. Child., January, 1931, XLI, 153.

The author believes that the aphorism "All is not asthma that wheezes," should be

inculcated into every medical student. The wheezing referred to is that heard at the open mouth of the patient—not by ascultation through the wall of the chest.

Conditions in which wheezing occurs are listed under the following headings: (1) Compression stenosis, such as foreign bodies in the esophagus, thymic compression, substernal goiter, and adenopathy; (2) bronchial obstruction of the by-pass, check-valve, or stop-valve types, due to cicatricial stenosis, foreign bodies in the air or food passages, subglottic laryngitis, papillomas, pulmonary abscess, bronchiectasis, and, lastly, asthma. The obstruction in the last three conditions is due to the secretions present.

The author concludes that if a patient presents a wheeze, there is always some obstruction in the larger air passages, that most often a foreign body is the cause of the obstruction, and next in frequency is a secretion. He does not believe that obstruction in the smaller bronchi causes wheezing, audible at the open mouth. In his opinion, bronchoscopic examination always reveals the mechanical cause of the wheezing, and co-operation of the pediatrician, roentgenologist, and broncho-esophagoscopist is all-important.

F. B. MANDEVILLE, M.D.

CONTRAST MEDIA

A New Method for the Roentgenologic Demonstration of the Liver and Spleen by Injection of a Contrast Medium (Hepato-Lienography). P. Radt. Med. Klinik, Dec. 19, 1930, XXVI, 1888.

Certain colloidal substances, given parenterally, are deposited in the reticulo-endothelial system, especially in the liver and spleen. A thorium-dioxide-sole (made by the chemical works of Heyden) was used and proved to be harmless for animals and human beings. From 40 to 80 c.c. were given to human beings, injected in doses of from 10 to 20 c.c. daily. Occasionally a slight malaise was noticed three or four hours after the intravenous injection. All animals which were used for these experiments over a year ago are still alive. Histologic examination did not show any anatomical changes, except the presence of small yellow granula in some cells, which is the thorium-dioxide. Blood and urine examinations were normal in the animals as well as in the human beings.

The liver and spleen in normal individuals are shown plainly in the roentgenograms as rather dense shadows. Twenty patients have received thorium-dioxide. Four cases are described and the roentgen films are reproduced. Negative round shadows in the liver in the first case proved to be caused by carcinomatous nodules (autopsy). In the second case there was a good contrast shadow of the spleen, but almost none of the liver. A liver cirrhosis was suggested by these findings and confirmed by autopsy. The third case again showed multiple round filling defects of the liver, caused by metastases of a pancreatic carcinoma (autopsy). The same was found in another case. The author hopes that this new method may lead to progress in the diagnosis of many diseases of the liver and spleen.

H. W. HEFKE, M.D.

The Practical Use of Varicography. Max Wolf and Franz Remenovsky. Wien. klin. Wchnschr., March 13, 1931, XLIV, 353.

Abrodil was used for the roentgenologic demonstration of varicose veins and proved to be harmless. The authors show that in most cases the direction of the blood flow in superficial varicosities is mainly toward the periphery (contrary to the deep veins). In some cases they succeeded in demonstrating the deeper veins, which is of some importance after a deep-seated phlebitis. Even when using the exact technic (compression, direction of needle, metal rings, etc.), it was impossible to retain the solution in a certain part of the vein for any length of time.

H. W. HEFKE, M.D.

The Use of Lipiodol. R. C. Shawhan. United States Vet. Bureau Med. Bull., December, 1930, VI, 1049.

The author mentions the value of the use of lipiodol in the following conditions:

1. Pathologic conditions of the chest, such as bronchiectasis, lung abscess, cavitations, and tumors.

2. Gynecologic conditions, such as kinks and stenosis of the fallopian tubes, certain uterine conditions, and sterility.

3. Diseases of the vascular system; to locate obstruction, thrombi, and phlebitis.

4. Neurologic conditions, such as cord and brain lesions.

5. Visualization of the vas deferens and seminal vesicles.

6. Outlining of normal anatomy in the living subject.

The visualization of the lung fields and bronchial structures are discussed in detail. Supraglottic, intrabronchial, and cricothyroid injections are the methods of administration. The author expresses his preference for the supraglottic, because of its simplicity and ease of administration.

While in some cases one-fourth grain of morphine may be used about one-half hour before the injection, atropine should never be used because the dryness it induces is not desirable. The soft palate, base of the tongue, epiglottis, and larynx are anesthetized with a 10 per cent cocain solution. The patient is instructed to protrude his tongue, grasp it with a piece of gauze, and draw it forward. Using a warmed laryngeal mirror, the laryngeal syringe is introduced into the larynx, retracting the epiglottis slightly forward with its tip. In this manner, 15 c.c. of warmed iodized oil is injected during quiet respiration. The patient should then be examined in several positions by fluoroscopic and radiographic means. In bronchiectasis the shadows appear clubbed and beaded.

J. N. Ané, M.D.

Contrast Filling of the Knee Joint with Uroselectan. Lorenz Michaëlis. Röntgenpraxis, April 1, 1931, III, 320.

The demonstration of the knee joint, especially the cartilage, has been tried by injection of iodipin (iodinized oil) and air. Both have proved very unsatisfactory. Uroselectan seemed to offer all the advantages for a contrast medium which could be injected into the joint, and was tried in twelve patients. The technic is simple: From 40 to 60 cm. of a uroselectan solution are injected into the joint. Stereoscopic films are then taken immediately after the patient has flexed and extended the knee several times. Rest for 24 hours afterwards is advisable. The injection is harmless, and only one patient reacted with a slightly elevated temperature for 24 hours; occasionally some pain in the knee was noticed, which, however, did not last long. One hour after the injection, the density of the contrast medium is already definitely lessened and after from 3 to 5 hours it cannot be demonstrated. The density is not marked enough to obscure the bone, and the aqueous solution allows a uniform distribution in the joint. Its use is indicated in all chronic or recurrent cases of exudates in the knee or in cases of injury to the cartilage, but not in acute cases. It seems that this method may be the first step for the establishment of a diagnosis in injuries to the cartilage and meniscus.

H. W. Hefke, M.D.

EXPERIMENTAL STUDIES

Further Study on the Influence of an Aqueous Extract of Suprarenal Cortex on the Growth of Carcinoma, Sarcoma, and Melanoma in Animals. Kanematsu Sugiura. Am. Jour. Cancer, April, 1931, XV, 707-724.

This is a long detailed report regarding the effect of injections of suprarenal cortical extract into animals and chickens bearing carcinoma, melanoma, and sarcoma transplants, to which the reader is referred for details.

The author concludes that single or repeated subcutaneous or intramuscular injections of the cortical tissues showed no curative, retarding, or accelerating influence upon the tumor growth. Neither early tumor ulcerations nor prolongation of life were noted in the tumor-bearing animals.

John R. Carty, M.D.

Radiobiological Studies on Tissue Cultures. Hans Laser. Strahlentherapie, 1930, XXXVIII, 391.

The author undertook an extensive study of the sensitivity of normal and malignant cells to radiation by the tissue culture method. The source of radiation was a silver tube, 5 mm.

in length and 2.9 mm. in diameter, containing 5 milligrams of radium element. The silver screen was 0.2 mm. thick. It is stated that a similar applicator, containing 10 milligrams of radium equivalent, if placed directly on the skin, produced a mild erythema in fifteen minutes and a definite erythema in twenty minutes. The results are represented in numerous curves. It is concluded that the sensitivity can be compared on the basis of the inhibition in growth. Both sensitivity and latent time are definitely related to the velocity of proliferation. This holds for malignant as well as for normal cells.

Tissue cultures with experimentally reduced growth do not show any effect to small doses of radiation. After heavier doses which are, however, not lethal, the cultures slowly recover from the effect. Occasionally a temporary increase of growth was noted in the irradiated cultures, as compared with the controls. Preliminary irradiation followed by repeated transplantation of the cultures resulted in an increased sensitivity. Repeated irradiation of previously irradiated cultures does not increase the inhibition of growth. The biologic susceptibility of the cells as measured by the inhibition of growth corresponds to the product of time and intensity of irradiation. Carcinoma cultures show a particularly high sensitivity if irradiated first and then transplanted repeatedly. This is not regarded as a qualitative but a quantitative difference from normal cells.

ERNST A. POHLE, M.D., Ph.D.

The Rôle of the Parathyroids in Calcification, and Susceptibility of Parathyroidectomized Rats to Viosterol. David H. Shelling. Proc. Soc. Exper. Biol. and Med., December, 1930, XXVIII, 307.

The author noted that parathyroidectomized rats were more susceptible than normal rats to hypercalcification when produced by viosterol or by diets containing calcium and normal or high phosphorus concentrations. The effect of viosterol hypercalcification in the parathyroidectomized animals was absent on a very low calcium intake, and more pronounced on a high phosphorus and optimal calcium diet. The possible relationship of dysfunction of the parathyroids to the abnormal calcification, such as in Paget's disease, juvenile sclerosis, renal sclerosis, otosclerosis, and general arteriosclerosis is mentioned.

J. N. ANÉ, M.D.

Experimental Induction of Tumors with Blast-furnace Tar. I. Berenblum. The Lancet, Dec. 20, 1930, CCXIX, 1344.

These experiments were the outcome of investigations originally undertaken to discover the reason for the failure of certain tars to induce tumor growth. The prevalent view is that the carcinogenic action of tars is due to certain "specific carcinogenic principles" contained, and, conversely, that those tars which are ineffective are deficient in these substances. The author had previously found that an active gas-tar could be rendered almost completely non-carcinogenic by the addition of 0.1 per cent of mustard gas (dichloroethyl sulphide), and that the inhibition was due to some action of the chemical on the animal, and not to any alteration of the tar itself. This suggested that a particular tar might appear to be non-carcinogenic, not because it lacked substances which were responsible for the tumors, but because the action of those constituents was masked by the presence of an inhibitory substance. The present investigation to test this hypothesis proved unsuccessful, because the extract of blast-furnace tar, which was assumed to be non-carcinogenic, actually produced tumors when applied to the skin of mice.

Up to this time, blast-furnace tar has always been considered to be entirely lacking in carcinogenic power, and this view is based on both clinical and experimental evidence. Epitheliomatous lesions of the skin are not uncommon among workers in gas-tar factories, but no such lesions have been observed among those who are in daily contact with blast-furnace tar. There is no record at the Home Office of a case of skin malignancy from blast-furnace tar, although there are 520 (with 79 deaths) reported from pitch and tar in the ten years from 1920 to 1929, and the total from pitch, tar, paraffin, and oil during the same

years was 1,151, with 296 deaths. Leitch, in 1923, tried the effect of a Scottish blast-furnace tar on the skin of mice and, although it was continued for eight months, no tumors were produced. Others studying the action of different tars have come to the same conclusion. In view of this evidence, the discovery that an extract of such a tar (Scottish blast-furnace) would lead to tumor development in mice, called for further inquiry.

In the original experiment an ether extract of the blast-furnace tar was used. Twenty-five of the forty-five mice originally subjected to the tarring developed tumors. On histological examination, seven of these were found to be malignant. The fact that an ether extract of the tar was used suggested the possibility that the chemical treatment might have been responsible for this action. The experiment was then repeated with untreated tar on two series of mice, the first of 50, and the second of 100. In the first experiment the mortality was very high, but, in spite of this, five of the animals developed tumors, one of which was a spindle-cell sarcoma, and the other four were simple warts. The sarcoma developed under the treated area of skin. Of the 100 mice, 20 acquired tumors, 2 of which were squamous carcinoma, and 19 simple warts.

The author believes that the only conclusion is that the sample of blast-furnace tar used in these experiments, though not as potent as gas-tar, is definitely capable of inducing tumors in mice. To be sure that there was no difference in the tar used by the author and by other workers, a careful survey of the source of the tar was made, including chemical examination, and it was found to differ in no essentials from tar used by other workers. The author believes that the fact that gas-tar and blast-furnace tar are both carcinogenic, despite the differences in their chemical composition, must be considered of some significance, particularly in relation to the controversy on the "specificity of carcinogenic agents."

So far, no case of skin cancer arising from contact with blast-furnace tar has ever been reported, but even if it be assumed that any agent which is carcinogenic for mice must necessarily also be carcinogenic for man, it is still not justifiable to presume that the workmen who handle the tar should necessarily develop cancer of the skin, for it is possible that they do not handle the tar frequently enough or for a sufficient length of time for the condition to develop, particularly as blast-furnace tar appears to be less potent than gas-tar. At the same time, it must be realized that regulations dealing with hygienic measures and medical inspection need not be so strict for blast-furnace tar workers as for those who come into contact with gas-tar, pitch, paraffin, and oils. Therefore, it is not unreasonable to imagine that, with more careful medical supervision, cases of cancer, due to blast-furnace tar, may yet be found in those industries in which workmen are liable to come into intimate contact with the tar.

H. J. Ullmann, M.D.

The Influence of Red and Blue Rays on Growth. Fritz Ludwig and Julius v. Ries. Strahlentherapie, 1931, XXXIX, 485.

Rats were kept in cages and exposed to either blue or red radiation; other rats were exposed to daylight filtered through ordinary glass serving as controls. A definite increase of growth was noted in the animals exposed to the red rays alone. It is suggested that the results of this experimental observation might be of use in pediatrics.

Ernst A. Pohle, M.D., Ph.D.

Radiobiologic Experiments on the Germ Cells of the Sea Urchin. H. and M. Langendorff. Strahlentherapie, 1931, XL, 97.

The authors studied the effect of one quality of roentgen rays on cells in different stages of mitosis. Ova and sperma of the sea urchin *(Psammechinus miliaris)* were exposed as follows: 180 K.V., 5 ma., 3.0 mm. Al, 10 × 15 cm. field, arranged so as to avoid back-scattering, from 50 to 400 r. The variation in the exposure time was not more than in the ratio of one to two. Sperma was irradiated and used for the impregnation of normal eggs; eggs were irradiated and impregnated with normal sperma; eggs and sperma were irradiated before impregnation, and, lastly, im-

pregnated eggs were irradiated. It appeared that the injury to the cells was proportional to the roentgen dose. The results were plotted, and they always approached an exponential curve. The sperma seemed to be more sensitive to the roentgen rays than the ova. Irradiation carried out at intervals of five minutes following impregnation showed that the maximum injury takes place immediately after impregnation, decreases slowly, reaches a minimum during the metaphase, and increases again with the anaphase.

ERNST A. POHLE, M.D., Ph.D.

Experimental Cancer Research. William H. Woglom. Am. Jour. Med. Sci., February, 1931, CLXXXI, 157.

The author reviews the advances made in the past thirty years in experimental cancer research, and its possible relation to the cancer problem as applied to the human body.

He finds that in this period a vast amount of material has been collected, many previous theories disproven, and research established on a rather firm and much narrowed basis. A good start has been made on such problems as the chemical nature of a carcinogenic agent in tar, the intensity and duration of irritation required to initiate neoplasia, the relation of age to the development of cancer, etc.

ROE J. MAIER, M.D.

Experiments Concerning the Influence of Short Electric Waves on the Growth of Bacteria. W. Haase and E. Schliephake. Strahlentherapie, 1931, XL, 133.

The apparatus used by the authors for the production of electric waves of from 3.5 to 20 meters is briefly described, employing a circuit devised by Esau. They studied the following questions: Are bacteria injured or killed if brought into the condenser field? Does the effect of the condenser field on bacteria run parallel to the temperature? What influence has the wave length? Is it possible to influence infections in animals?

Comparisons of cultures placed in the water bath at equal temperature with those in the electric field showed that the bacteria died quicker in the latter. Therefore, the increased temperature is not the only cause of death. In some bacteria the results obtained were not uniform. For staphylococcus, waves of 3.5 and 20 meters have an optimal effect; 6-meter waves have little effect. If tuberculosis bacilli were injected into the knee joints of guinea pigs, a definite retardation of the pathologic process was noted if the animals were placed in the condenser field.

Emphasis is laid on the statement that the results reported are only of a preliminary nature. Further studies must be undertaken before the general therapeutic use of these electrical waves can be recommended.

ERNST A. POHLE, M.D., Ph.D.

GALL BLADDER (NORMAL AND PATHOLOGICAL)

The Differential Diagnosis between a Calcified Gall Bladder and Solitary Stone or Cyst. Franz Herz. Röntgenpraxis, April 1, 1931, III, 307.

By using different projections, the author shows that the calcified gall bladder may be seen either as a closed circle or as a pear-like structure. This facilitates the differential diagnosis from solitary stone or cyst. In the four cases which are described, the calcification of the gall bladder was not responsible for the symptoms, and one should not overestimate its importance (in two cases a hypernephroma was found).

H. W. HEFKE, M.D.

Simultaneous Roentgenographic Visualization of Gall Bladder and Urinary Organs. B. Varela Fuentes and P. Rubino. Deutsche med. Wchnschr., Feb. 27, 1931, LVII, 364.

In patients with symptoms referring to the right upper quadrant, combined pyelography and cholecystography is often desirable. The authors carried out experiments on dogs and rabbits, and found that uroselectan and tetraiodin may be injected without producing intoxication. In clinical practice, the authors proceed as follows: Three grams of uroselectan are dissolved in 70 c.c. of double distilled water. Three grams of tetragnost (Merck) are dissolved in 30 c.c. of water.

The uroselectan is injected first in about 15 minutes and immediately after that, with the same needle, the tetraiodin is injected in about 3 minutes. The injection is done at eight o'clock in the morning before the patient has taken any food and after the necessary preparation of the bowels on the preceding day. Films are taken 15 and 45 minutes following the injection. The patient returns in 12 hours and 16 hours for additional films. If roentgenograms are taken 4 hours after the injection, it is possible to make topographical studies of the abdominal organs.

ERNST A. POHLE, M.D., Ph.D.

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

The Rôle of the Pyloric Sphincter in the Behavior of Gastric Acidity. Robert Elman and A. P. Rowlette. Arch. Surg., March, 1931, XXII, 426.

A study of the acid control of the pylorus was made, a theory which was advanced by Cannon in 1907. The authors state that acid on the stomach side opened the pylorus, and on the duodenal side closed it.

From these studies they recommend the conception of the pyloric control of gastric acidity rather than that of unqualified acid control of the pylorus. They also discuss the clinical implications from this theory.

HOWARD P. DOUB, M.D.

Foreign Bodies in the Gastro-intestinal Tract of Psychotic Patients. Henry J. Kellum. United States Vet. Bureau Med. Bull., January, 1931, VII, 50.

The author reports the case of a patient with dementia præcox of the catatonic type, who, on several occasions, attempted suicide. After hospitalization he developed many gastric attacks and it was discovered each time that these resulted from the ingestion of foreign bodies of all varieties. In the final attack it was believed that all had passed, with the exception of a nail, the shadow of which was seen on the roentgenogram. Laparotomy revealed numerous pus pockets, with adhesions, but no foreign bodies. The patient subsequently developed empyema and died.

Postmortem examination of the abdomen showed a mass of adherent intestine, which could not be separated. In this mass was found the nail and several other foreign bodies which were not opaque to the X-rays. In this case, a localized peritonitis had resulted which was followed by thrombosis and embolism. These, in turn, were followed by pulmonary infarction, with pyo-pneumothorax.

The author does not believe it possible to base prognoses on the size, shape, and number of foreign bodies. Medical treatment of an expectant nature should be tried first and surgery resorted to only when definite indications arise.

J. N. ANÉ, M.D.

The Roentgenologic Appearance of Rare Diseases of the Stomach. Kurt Kremser. Röntgenpraxis, April 1, 1931, III, 289.

Several cases of rare diseases of the stomach are described. The first case is that of a lymphosarcoma of the stomach, which presented itself as a large irregular filling defect on the greater curvature. Roentgenotherapy greatly reduced the size of the spleen, which was very large before treatment, but did not seem to influence the tumor of the stomach. An autopsy confirmed the diagnosis.

Two cases of gastric syphilis are described. In one case the microscopic examination of the resected pylorus gave the typical appearance of a syphilitic process. The roentgenologic appearance was that of a pyloric malignancy. Another case showed a consistent hourglass-like contraction in the median part. It is conceded by all authors that a definite differential diagnosis between sarcoma, lymphogranuloma, syphilis, or tuberculosis of the stomach from a carcinoma cannot be made roentgenologically.

Leukemic infiltration of the gastric mucosa is described. There were many oval and fairly well circumscribed small defects visible on roentgenologic examination. In another case the blood picture indicated a myelogenic leukemia. An irregular filling defect in the

pyloric region was thought to be a leukemic tumor, but proved in the further course of the disease to be carcinomatous. One should not forget that tumors, of the gastro-intestinal tract especially, may show a leukocytosis with myelocytes (Nägeli).

The roentgenologic appearance of two cases of cicatricial constriction of the stomach after ingestion of zinc chloride is described. If a diagnosis can be made from the history, the recognition is easy. If not, it is hard to differentiate it from an infiltrating tumor by the roentgenologic examination alone.

In two cases it is shown that one must be very careful in diagnosing a "malignant relief" from the appearance of the mucosa. Multiple tumor-like filling defects were presented, which, however, changed their appearance on repeated examinations. A normal mucosa was seen shortly afterward (five, respectively, one week later). Only this fact made a diagnosis of gastritis possible.

H. W. Hefke, M.D.

Serial Radiography of the Pyloro-duodenal Tract: An Apparatus Answering All the Demands of the Technic. R. Herdner. Arch. d'Électricité Méd., March-April, 1930, XXXVIII, 164.

The author describes an apparatus which he has devised and constructed for the purpose of taking roentgenograms of the duodenum and pyloric antrum. These are deep abdominal organs and the shadow of the duodenum is extremely mobile, intermittent, and transitory, necessitating a rapid exposure when the roentgenographic method is used. The above disadvantages are likewise manifested during fluoroscopy, which is especially dangerous to the operator. Because of the relative haziness of the shadow, one is tempted to further increase the penetration, likewise the danger of this method of examination.

In using this apparatus the author claims that much of the hazard is eliminated, for the operator, shielded by a lead barrier, watches for the appearance of the image of the pylorus and duodenum on the fluoroscopic screen, and at this instant, by means of a relatively simple device, he is able to immediately fix the shadow on a film.

J. N. Ané, M.D.

A Case of Leiomyosarcoma of the Stomach. Leon Schiff and Margaret Foulger. Jour. Am. Med. Assn., March 21, 1931, XCVI, 942.

This is a case report of a white man, aged 50, with no previous abdominal pain and no digestive disturbances other than occasional flatulence and eructation of sour material. A firm mass presenting a distinct edge and descending freely on inspiration was felt to extend well below the left costal margin in the mid-clavicular line. It was thought to be an enlarged spleen. The red cells numbered 4,500,000 per cubic millimeter and the hemoglobin was 55 per cent (Dare).

A fluoroscopic examination revealed a large irregular niche in the lesser curvature of the stomach, several inches above the pylorus. This was interpreted as a subacute perforating gastric ulcer, related to the mass thought to be spleen.

Exploratory laparotomy showed a tumor mass in the posterior wall of the stomach, extending upward to the lesser curvature. Incision through the gastrocolic omentum elicited a large amount of foul smelling pus. At necropsy, this proved to be a leiomyosarcoma, involving the lesser curvature and posterior wall, with an ulcer 7 mm. in diameter, which had perforated the posterior wall and communicated with a walled-off abscess cavity in the lesser peritoneal sac.

Charles G. Sutherland, M.D.

GASTRO-INTESTINAL TRACT (THERAPY)

The Indispensable Uses of Narcotics in the Treatment of Diseases of the Gastro-intestinal Tract. Robert A. Hatcher. Jour. Am. Med. Assn., May 2, 1931, XCVI, 1475-1477.

Diarrhea is the most common disease of the gastro-intestinal tract for which narcotics are used. An understanding of the physiology and pharmacology of this region is essential for

the treatment of diarrhea. The diet exerts a profound influence on the entire digestive tract. The rôles of the sympathetic, the vagus, and the plexuses of Auerbach and Meissner in the normal gastro-intestinal tract are not known. Diarrhea results from exaggerated normal peristalsis, frequently with excessive secretion; hence the necessity of discussing the normal movements of the gastro-intestinal tract. For children, the official chalk mixture or lime water is recommended. Papaverine is less certain and prompt than morphine. Codeine has comparatively little influence in the intestinal peristalsis.

Because the common causes of diarrhea and the methods of treating it differ in many ways in infants and in adults, these are considered separately.

Treatment is divided into "correction of causes" and "drugs." Patients should be trained to observe any disturbing effect of various foods. Enemas are preferred to cathartics for dry, hard, impacted feces. Hydrochloric acid is an extraordinarily active antiseptic. Castor oil is a mild non-irritating laxative, useful in children and adults. Potassium and sodium tartrate or magnesium sulphate is equally effective. The early administration of morphine or opium may do incalculable harm. Bismuth subcarbonate is preferable to the subnitrate. Tannic acid in the form of gambir or acetyltannic acid is useful. Hypnotics of the barbital type allay nervousness and frequently diminish intestinal peristalsis.

CHARLES G. SUTHERLAND, M.D.

Roentgen Therapy of Gastric and Duodenal Ulcers. A. Grosglik. Strahlentherapie, 1931, XL, 286.

Twenty cases of ulcer of the stomach and 11 cases of ulcer of the duodenum were treated by roentgen rays (180 K.V., 0.5 Zn or Cu + 4.0 Al, from 75 to 100 per cent erythema surface dose, distributed over from 5 to 7 days; 1 large anterior and posterior field). One series was given in 12 cases, 2 series in 8 cases, and 3 series in 11 cases. The intervals between the series were from one to several months. Nausea followed the treatment in 14 patients, 4 developed rather severe X-ray sickness, and 5 could not be traced. The remaining 26 were observed for from 3 months (11) up to 6 and 12 months (15). The most striking result was the relief from pain. It disappeared completely in 5 out of the 11 cases; 3 had less pain but it returned after meals, and 2 obtained temporary relief. Four out of the 15 cases had no pain during the entire period of observation. In 9, it disappeared for several months but returned within a year. In 2, there was only a slight improvement, and one case developed a recurrence which necessitated operation after six months. The relief from pain did not begin immediately after the first treatment, but took from several days to as many weeks before the effect became noticeable. Other symptoms as, for instance, flatulence, constipation, bleeding, lack of appetite, nausea, and vomiting were often favorably influenced before the pain decreased.

The paper concludes with a discussion of the possible mechanism of the effects of roentgen rays on gastric and duodenal ulcers.

ERNST A. POHLE, M.D., Ph.D.

A Case of Pyloric Obstruction Responding to Medical Treatment. Walter de M. Scriver. Canadian Med. Assn. Jour., January, 1931, XXIV, 99.

This is a case report of a patient, a male, 73 years of age, who, up to the middle of April, 1930, had enjoyed good health. At that time he first noticed a dull pain in his upper abdomen, associated with constipation and anorexia. Three weeks later he commenced to vomit, at first at intervals of one or two days, large amounts of coffee-ground material, which came up suddenly, with very little associated nausea. Later the vomiting became more frequent, usually an hour or two after meals, with relief of the pain. The loss of weight was marked, and his strength failed rapidly.

A barium examination was reported as follows: "After six hours, about 50 per cent of the meal remains in the stomach—the rest lies in the ileum. The stomach is large, J-shaped, is seen to contain fluid, and has no irregu-

larities. Good peristalsis, but no cap forms. Twenty-four hours later, about 50 per cent of the meal remains in the stomach."

An X-ray diagnosis was made of "pyloric stenosis, caused probably by a duodenal ulcer, and giving rise to at least twenty-four-hour retention."

On account of his age and poor physical condition, operation was not advised. The stomach was washed out twice daily, and intravenous injections of 400 c.c. of 20 per cent glucose in normal saline, followed by 100 c.c. of normal saline, were given morning and night. In addition, on the third day, feedings of 250 c.c. of orange juice, eggnog, or milk, in rotation, were given every three hours during the day. For some time there was no change in the gastric retention, but, as he refused operation, the treatment was continued, gradually increasing the feedings. With the morning gastric residue at 600 c.c. the patient was sent home with instructions to follow the same diet and wash out the stomach each morning before taking food. He was observed at frequent intervals, and as the gastric residue gradually reduced, the feedings were increased. In six months' time, the gastric morning residue completely disappeared, and the lavages reduced to one a week. The patient feels much better, has gained thirty pounds in weight, and attends to his usual business. A recent X-ray examination showed the stomach empty at six hours. The stomach was normal in size and tone, and a normal duodenal cap was seen.

This extremely interesting case is from the Department of Medicine, McGill University Clinic, Royal Victoria Hospital, Montreal.

L. J. Carter, M.D.

GENITO-URINARY TRACT (THERAPY)

Diathermy in Nephritis. W. Ewig. Deutsche med. Wchnschr., Jan. 9, 1931, LVII, 51.

Following an analysis of the effect of diathermy on the kidney function, and the report of two cases of acute nephritis that had been benefited by diathermy, the author presents the following conclusions: Diathermy of the normal kidney leads to an increased diuresis; acute glomerular nephritis is influenced materially by intense diathermy to the kidneys; eclamptic conditions usually disappear without any other therapeutic measures, if diathermy is given to the kidneys and to the head. In sub-chronic and chronic nephritis, the results are questionable. The cerebral symptoms of kidney insufficiency are influenced favorably by diathermy applied to the head.

Ernst A. Pohle, M.D., Ph.D.

Treatment of the Insufficient Kidney by Thyroid Extract and Roentgenotherapy. A. Hermann Müller. Deutsche med. Wchnschr., Feb. 6, 1931, LVII, 230.

In two cases of uremia, due to arteriosclerotic kidney disease and to sub-chronic glomerular nephritis, the author obtained considerable improvement following the administration of thyroid extract and X-ray therapy to the kidneys. The technic was as follows: 170 K.V., 4 ma., 30 cm. F.S.D., 8 $\times$ 10 sq. cm. field, 0.5 mm. copper plus 1.0 mm. aluminum, 70 per cent E.D. The effect of this treatment on the diuresis, the disappearance of albumin from the urine, and the drop of the blood pressure were particularly striking.

Ernst A. Pohle, M.D., Ph.D.

GRENZ RAYS

Grenz-ray Therapy in Skin Diseases. Franz Blumenthal and Lothar Böhmer. Deutsche med. Wchnschr., March 6, 1931, LVII, 404.

In Grenz-ray therapy, the exact measurement of the quality and quantity of radiation is of prime importance; besides this, the correlation of the physical dose with the biologic effect must be established. The authors believe that the safest method is to determine the threshold erythema, since marked pigmentation remains for a long time following high doses. In view of the fact that severe erythema reactions have been observed even in institutions where the dose is carefully controlled by ionization measurements, the general

use of these long wave lengths of roentgen rays can not be advocated. In their own clinic, the authors have applied from 400 to 500 r at from 9 to 10 K.V., 10 ma., 12 cm. F.S.D., at intervals of from one to two weeks, up to three times per area.

A comparison of the results obtained in a number of skin diseases with those following ordinary roentgen therapy revealed the fact that there existed apparently no difference in the results, except for a somewhat slower action of the Grenz rays. The general body exposure did not lead to different results in the authors' experience than those obtained by ultra-violet irradiation.

ERNST A. POHLE, M.D., Ph.D.

Therapy with Long Wave Length X-rays (Grenz Rays). Francis Carter Wood and George M. MacKee. Jour. Am. Med. Assn., Jan. 10, 1931, XCVI, 111 (Reprinted in "Radiology," May, 1931, XVI, 697).

It has long been known that the commercial X-ray tube emits practically no X-rays when run at a voltage of 10 kilovolts or less. The reason for this is the high absorptive power for the long wave length rays of the glass from which tubes are made. Lindemann showed that if a lithium borate glass was used, and the thickness kept low, X-rays of considerably longer wave length would escape from the tube than if ordinary glass were used.

The special tube which is most popular for this purpose is a small, water-cooled, unipolar, hot-cathode glass tube which, with the exception of the Lindemann glass window, is encased in a metal housing. The tube is delicate and its life is likely to be short. It is important not to touch the Lindemann glass window.

The biologic effects, apparatus, tube, and cutaneous reactions are described and discussed.

The best field for Grenz-ray therapy is in dermatology. While the radiation is a valuable therapeutic agent, it is less efficacious, less versatile, and more time-consuming than X-rays of shorter wave length. In spite of the higher degree of safety, the method is not yet suitable for use by others than those who have been adequately trained in X-ray work.

It is especially suitable when it is necessary to avoid temporary or permanent injury to important organs and to glandular apparatus in or under the true skin, such as hair roots, sebaceous and sweat glands, testes, and the eyes. The method is comparatively safe and very useful for patches of various dermatoses located on the scrotum, eyelids, and scalp—eczema, psoriasis, lichen planus, lupus vulgaris, and basal-cell epithelioma.

Good results for the indirect Grenz-ray treatment are claimed for gastric ulcer, gastric hyperacidity, Banti's disease, polycythemia rubra, hypothyroidism, dysmenorrhea, oligomenorrhea, amenorrhea, hypertrichosis, asthenia, arthritis deformans, asthma, pertussis, angina pectoris, and spastic constipation. Indirect treatment was used successfully in a number of skin diseases such as acne vulgaris, acne rosacæ, universal erythroderma, and urticaria. The effect on acne rosacæ is said to be especially good. Exophthalmic goiter, Hodgkin's disease, and leukemia are not favorably influenced. The results of indirect Grenz-ray treatment have not yet been corroborated to any extent, and only a few cases of each disease have been reported.

A comprehensive bibliography is appended, as "suggested references for future reading."

CHARLES G. SUTHERLAND, M.D.

The Treatment of Lupus Vulgaris with Grenz Rays. B. Spiethoff. Strahlentherapie, 1931, XL, 245.

The author has obtained excellent results with borderline rays, in the treatment of lupus vulgaris. He applied rather high doses, namely, from 4,600 to 25,000 r in one sitting (9 K.V., 10 ma., 2.5 cm. F.S.D.). At 2½ cm. distance the diameter of the exposed area is about 3 centimeters. The total cost of the treatment was usually very reasonable. This is an important economical factor. Lower doses (1,150 to 2,300 r) are indicated if the active lesion lies in an atrophic area. The exact procedure must be adapted to the particular needs of each case.

A number of photographs showing patients before and after treatment are appended.

ERNST A. POHLE, M.D., Ph.D.

GYNECOLOGY AND OBSTETRICS

The Diagnostic Value of Radiology in Obstetric Practice. Noel Hypher. British Jour. Radiol., April, 1931, IV, 171.

This article deals with the roentgenologic studies made on 105 selected cases from 18,000 routine obstetric cases passing through the Antenatal Department of Queen Charlotte's Hospital. The author considers antenatal radiographic examination as a definite additional diagnostic method of value in reducing both the maternal and fetal mortality rate.

With films of good technical quality, beginning ossification of the head and spine should be demonstrable consistently after the sixteenth week. Methods of lipiodol injection into the uterus, pneumoperitoneum, etc., for earlier diagnosis, may contribute supportive evidence to the presumptive diagnosis of pregnancy, but the findings are, of course, not pathognomonic.

Ovarian cyst, complicating or simulating pregnancy, may be recognized by showing the fetus pushed to one side, and a large homogeneous shadow occupying the remainder of the abdomen.

Disproportions of the presenting part to the pelvic inlet and internal pelvic measurements may be made. In the latter procedure, the author uses an ordinary metal pelvimeter, applied to the spine of the fifth lumbar vertebra and symphysis pubis, in order to get the inlet parallel to the film. To determine the actual diameter from the film measurements, he utilizes this factor of correction:

$$\frac{\text{(Tube distance from film)} - \text{(Distance of fifth lumbar spine)}}{\text{(Tube distance from film)}}$$

Pelvic bone deformities in the nature of bony tumors or kyphotic or rachitic pelves can likewise be shown radiographically

The demonstration of the ossified epiphyseal center at the lower end of the femur is considered the best X-ray evidence of the fetus being at term. Complicated presentations (more often in multiple pregnancy) and fetal abnormalities (anencephaly, hydrocephaly), etc., are usually clearly demonstrable at a definite interval before term.

The roentgenograms accompanying the article are of unusually good quality.

J. E. HABBE, M.D.

Roentgenologic Diagnosis of a Quadruplet Pregnancy. G. J. Pfalz. Röntgenpraxis, April 1, 1931, III, 328.

The diagnostic value of a roentgenologic examination in anomalies of the later pregnancy has been definitely established. The film is the first one, to the author's knowledge, to show quadruplets. Repeated roentgenograms were made during the delivery, and were of value for the prognosis and treatment.

H. W. HEFKE, M.D.

Birth of a Living Child after Irradiation of Carcinoma of the Portio. E. Philipp. Ztschr. f. Geburtsh. u. Gynäk., Dec. 30, 1930, XCIX, 179.

The author gives a detailed report of a case in which a living, normal child was born to a V-para, aged 45, three years after radium irradiation of the portio for carcinoma, which resulted, three months after treatment, in abortion of a pregnancy existing at the time. Examination three years after the birth of the child showed severe shrivelling of the portio and shortening of the vaginal arch, with the uterus small and anteflexed. According to the woman's own statement, the delivery required a slightly longer time than was the case in earlier labors, but was accomplished without artificial aid.

In his comment on the case, the author makes the statement that radium offers the only possibility for treating carcinoma without destroying the function of the uterus and the ovaries.

X-rays in the Diagnosis of Pregnancy: Are They Injurious to Fetus or Ovary? L. H. Garland. California and Western Med., March, 1931, XXXIV, 150.

The author endeavors to show that from the third month on, with good technic, the

fetal shadows should show on the X-ray film. They will be faint, except in perfect films, and show the spine as a row of beads and the occiput as a crescent; later the thin lines of the rib cage are shown. The oblique position is often helpful when the parts are small and overlie the sacrum. In the experience of the author, the spine and occiput have been demonstrated after the twelfth week. After the fourth month, with good technic, a positive diagnosis should be made without exception, unless the patient is excessively stout.

He also discusses the question of injurious effect of irradiation of the fetus *in utero* and can find no report of a single injury to the mother or fetus when the X-rays have been used for purely diagnostic purposes. Again he makes the assertion that the X-ray demonstration is the earliest positive proof of pregnancy.

F. B. Sheldon, M.D.

Physical Methods of Treatment in Gynecology. Friedrich Voltz. Therap. d. Gegenw., January, 1931, LXXII, 29-34.

In this article the author reports the results of X-ray treatment of carcinoma of the female genital organs in the Döderlein Institute in Munich. During the ten-year period from 1913 to 1923, a total of 1,319 cases of carcinoma of the cervix were treated with X-ray therapy. Of this number, 222 were free from recurrence at the end of a five-year period, making a recovery percentage of 15.4. It should be noted that the 1,319 cases included the incurable ones and those with bad prognosis. During the period from 1923 to 1925, an additional group of 171 cases was treated. Among these were 40 cases free from recurrence at the end of the five-year period, a recovery percentage of 23.3. The improvement over the earlier group the author attributes to improved methods of treatment.

Divided into groups, according to the classification of Döderlein, the recovery statistics were as follows:

Group I, operable cases.....41 per cent
Group II, borderline cases .....23 per cent
Group III, inoperable cases .....11 per cent
Group IV, incurable cases.....4 cases

Similar results were obtained in the other genital carcinomas; the statistics for body of the uterus were as follows:

Total material .....41 per cent
Operable cases .....66 per cent
Recurrent cases .....10 per cent

For carcinoma of the vagina and vulva, the recovery percentages were 5 and 12 per cent, respectively.

The author compares these statistics with the averages obtained from the figures given in the literature which he found to be as follows:

Carcinoma of the cervix (percentage of all cases) .....17.4 per cent
Carcinoma of the cervix (operable and borderline) .....42.7 per cent
Carcinoma of the body of uterus (percentage of all cases).....35.6 per cent
Carcinoma of the body of uterus (operable cases) .....56.5 per cent

In the remainder of the article the author discusses the use of X-ray therapy in temporary sterilization, menorrhagia, and metropathia. There is also a discussion of light treatment, with the various types of lamps, and of electrotherapy.

The Gynecologic Measurement of the Pelvis by Means of the Roentgen Rays. Walter Schaefer. Röntgenpraxis, Feb. 1, 1931, III, 97.

The rather extensive literature on the subject of pelvic measurement by means of the X-ray is reviewed. The technical difficulties and the routine, as followed by the author, are described in detail. The conclusions reached by the author state that it is possible to get correct measurements of the pelvis. It is, however, not yet possible to measure the head of the fetus with any amount of certainty. The relationship of the size of the fetal head and the bony pelvis is the most important factor for the obstetrician, and the roentgenologic examination has not yet achieved success in this particular question. In spite of it, the measurement of the pelvis by means of the X-ray, which is correct if proper technic is used, has been of valuable help in many cases.

H. W. Hefke, M.D.

The Three-field Method of Castration and its Value. W. Dietrich. Röntgenpraxis, Feb. 15, 1931, III, 186.

Holfelder's three-field method of castration is highly recommended by the author as a further improvement over other technics. One hundred fifty patients have been treated in this way. An application of 270 r over the uterus and ovaries is successful in all patients between the ages of 35 and 40, and the nearer the climacteric, the smaller the dose. There is no question but that irradiation therapy is superior to surgery in most cases. The surgical mortality is still about 3.5 per cent, while a statistical survey of 11,341 irradiated cases showed a mortality of only 0.18 per cent. Compared with other methods (Seitz and Wintz, Gauss, Béclère, Fürst), the one of Holfelder has the advantage of the most homogeneous distribution of the rays, the greatest safety, and the shortest time of application.

H. W. Hefke, M.D.

LIGHT THERAPY

Effect of Light on Bacteria. O. Winterstein. Strahlentherapie, 1931, XXXIX, 619.

In the study of the bactericidal effect of light, one must differentiate between the effect on bacteria in cultures and bacteria in their natural surroundings. Experiments as to the bactericidal action of ultra-violet rays from a quartz mercury vapor lamp led the author to the following conclusion: It is possible very easily to kill bacteria which settle down on the floor or on the surface of objects. Bacteria suspended in air can be decreased in number by ultra-violet light. Garden soil could not be sterilized by an exposure of one hour. Irradiation of the human skin with ultra-violet light reduced the number of bacteria considerably. In infected wounds in human beings even high doses did not kill all bacteria. This procedure has, therefore, no great practical value. Dried pus exposed for one hour became sterile. If the layer of pus was made a few millimeters thick, pneumococci and streptococci were not killed. Silk used for surgical sutures which had been contaminated with staphylococci, streptococci, and coli could not be sterilized by an exposure of one hour at 75 cm. distance.

An extensive bibliography (over 4 pages, small print) is appended.

Ernst A. Pohle, M.D., Ph.D.

Concerning Ways and Means to Shorten Heliotherapy and Make It More Effective. Charles Brody. Strahlentherapie, 1931, XXXIX, 764.

Analysis of the present methods of light therapy and six years' experience in a great number of cases led the author to the conclusion that usually the dose applied in heliotherapy is too high. A temporary improvement is often nullified because the treatment has been carried on without interruption and continued for too long a time. The pigmentation and the lowered susceptibility hinder any further progress in healing. Pigmentation alone is no indication for the prognosis. As a number of case reports show, a pigmentation produced too quickly may lead to undesirable results. It is necessary to reduce the single dose and interrupt the treatments at certain intervals. After de-pigmentation has been brought about, a new series of treatments may be started, and a favorable reaction expected. The author combines heliotherapy with exposure to the mercury vapor lamp and a carbon arc lamp. The technic is given in detail.

In conclusion, it is emphasized that daily sun treatments of from three to six hours are too long—they should not exceed one hour. By inserting intervals to permit recovery of the skin, the total duration of the treatment can be shortened considerably.

Ernst A. Pohle, M.D., Ph.D.

Our Knowledge of the Quartz Mercury Vapor Lamp. V. Wucherpfennig. Strahlentherapie, 1931, XXXIX, 663.

The author conducted a number of tests with a quartz mercury vapor lamp. He confirmed the findings of other observers as to the closing and opening of the hood: opening leads to a drop in the potential and closing to

an increase. This may be explained by a change in the temperature surrounding the burner. The output is not directly related to the watt input, but depends upon the potential across the arc. In other words, the same product of volt, times amperes, leads to different intensities in the emission if the volt factor varies. A drop in the potential cannot be counterbalanced by a rise in the current. One test showed the following relations: lamp burned at 135 volts, 2.5 amperes equaling 338 watts; erythema time 3.15 minutes. At 96 volts, 3.75 amperes, also equaling 338 watts, the output dropped to 25 per cent. It is suggested, therefore, that a rheostat be placed in the current for balancing line fluctuations of plus or minus 10 per cent, and check it by a voltmeter. A thermostat in the hood could serve as control for the burner current. Graduation in degrees or in arbitrary units also seems advisable.

ERNST A. POHLE, M.D., Ph.D.

Remarks Concerning Various Sources of Artificial Light in Practice. A. Laqueur. Strahlentherapie, 1931, XXXIX, 643.

This is a brief discussion of the relative merits of a number of lamps available on the German market, with particular emphasis on the practical viewpoint.

ERNST A. POHLE, M.D., Ph.D.

A Method for the Absolute Measurement of the Erythema-producing Rays of the Quartz Mercury Vapor Lamp. O. Gaertner and G. Klovekorn. Strahlentherapie, 1931, XL, 383.

A measuring method for the radiation of the quartz mercury vapor lamp below 3,600 Å. has been worked out by the authors. It is based on the fact that silver barely reflects radiation below 3,600 Å. and is, therefore, easily heated by the shorter wave lengths. A small silver strip is placed over the joints of the thermocouple. For measuring the total output, a blackened manganin strip was used. The results with this arrangement were fairly satisfactory.

ERNST A. POHLE, M.D., Ph.D.

The Transparency of the Human Skin in the Region of 0.3–2.0 Micron. O. Gaertner. Strahlentherapie, 1931, XL, 377.

The author studied the transparency of the human skin for different wave lengths. A nitra lamp and a quartz mercury vapor lamp, in connection with a monochromator and thermocouples, were used. It appeared that in the region of 1.5 to 0.7 micron, the skin is most transparent and there is very little dependence of the wave length. Above 1.5 micron the transparency drops, showing the greatest individual differences in the violet and ultraviolet. Very little variation was found in the examined cases between 1.5 and 0.7 micron.

ERNST A. POHLE, M.D., Ph.D.

The Protective Function of the Skin against Light Rays. G. Miescher. Strahlentherapie, 1931, XXXIX, 601.

The author discusses the literature dealing with the protective properties of the skin against over-exposure to light. For a long time it was believed that the pigmentation was Nature's screen against ultra-violet rays. Experiments of his own convinced the author, however, that the thickness of the epithelium is, in all probability, the most important factor. This does not mean, of course, that the pigmentation is without any influence, particularly if it appears in the upper layers of the skin. Little is known as to the biologic effect of other spectral ranges. It may be assumed, though, that hyperemia and sweating are the reactions of the skin to prevent over-heating following exposure to red and infra-red light.

ERNST A. POHLE, M.D., Ph.D.

The Problem of Dosage in Heliotherapy of the Inner Organs. P. Roussel. Strahlentherapie, 1931, XXXIX, 787.

The dosage in heliotherapy depends on many factors; the most important are the clinical form of the disease, the individual susceptibility of the patient, and the intensity of the sunlight available. A fundamental rule is to interrupt the exposure if the patient shows fatigue. The treatment schedule is subdivided into three groups: patients whose treatment can be prolonged by five minutes

per day, by ten minutes per day, and by fifteen minutes per day. In the first group, only the lower legs are exposed, then are added the thighs; after about a month the abdomen, and lastly the thorax. This schedule must, of course, be modified in each case by the attending physician, based on clinical observations of the patient.

ERNST A. POHLE, M.D., Ph.D.

Stimulating Irradiation with Quartz Lamp in Constipation. Maximilian Grünsfeld. Ztschr. f. d. ges. physik. Ther., Nov. 24, 1930, XL, 28-30.

The author reports his results in 15 cases of constipation treated with quartz lamp irradiation. Two cases failed to respond but the other 13 showed decided improvement; in some the recovery was permanent and in others repeated irradiation was done with good results. In irradiation the author used burners with a constant current voltage of 220. The distance was chosen according to the sensitivity of the patient but irradiation was done in such a way as to induce a pronounced light erythema. The average distance was between 50 and 70 cm., and the time of exposure to the rays varied from 10 to 20 minutes. In some cases one irradiation was sufficient; in those in which repetition was necessary it was not done until all of the symptoms of irritation had disappeared completely.

Supersensitivity and Desensitivity to Light in the Origin and Treatment of Neoplasms: Study of an Actinic Theory of Cancer. R. Grynkraut. Arch. d'Électricité Méd., March-April, 1930, XXXVIII, 173.

In this discussion of the relationship of various factors in the origin and treatment of cancer, the author considers that the actinic theory does not oppose other views, for, being of a more general nature, it rather unites, classifies, and explains them.

It is believed that cellular division emits a light which has been found by Reiter and Gabor to lie in the ultra-violet spectrum, with a wave length of 340 μ. Muscles during contraction, according to Siebert, Frank, and Popoff, and the circulating blood during oxidation, as shown by Gurvitsch, act as sources of this light, which Gurvitsch described as "mitogenetic," for it was believed to influence the division of the nucleus of the resting cell. The circulating blood also contains potassium, which is radio-active. Zwaardemacker and Feenstra, after maintaining cardiac contractions in Ringer's solution, were able to replace the potassium by roentgen rays of 2,000 volts, and by cathode rays.

The author believes that the two factors which act together on the nucleus of the cell are the light agent and its sensitizer. This action is greater on the cell during division than when at rest. It was further observed that the effect of this light on a sensitive object was cumulative, as a feeble actinic agent which acted over a long period of time produced the same effects as one of greater intensity. Parthenogenesis has resulted from the application of very small quantities of radium to the eggs of sea-urchins and tritons. Since the egg was a cell sensitized to these agents, nuclear division resulted. This sensitivity, in which the effect of the agent was augmented by a better adaptation of the nucleus of the cell to the light wave, is discussed by the author as resonance. It follows, therefore, that a sensitized nucleus, receiving a series of shocks, will be stimulated to accelerated nuclear division. As the acceleration is increased, the nucleus and the cell will become less perfect, and finally a precancerous or a cancerous cell will result.

The sensitizing agents may be endogenous or exogenous. The organs of internal secretion act as endogenous sensitizers. The thyroid was found to accelerate cell division, while the thymus retarded this activity. Smoke, resulting from the burning of coal or oil, is an exogenous sensitizer. For this reason, the incidence of carcinoma is greater in industrial districts.

That this sensitivity to mitogenetic light may have an infectious origin, was shown by Lacassagne, who was able to produce sarcoma in rabbits by inoculation with *B. caviæ* and subsequent roentgen irradiation. According to the author, it is possible to think of this

sensitivity as approaching anaphylaxis, because magnesium has been found by Delbet to prevent the appearance of cancer. Magnesium, likewise, inhibits the anaphylactic state and may, therefore, be considered a desensitizing agent.

In the treatment of neoplasms, when radiotherapy is applied to a tumor which is sensitive to this form of therapy, there is produced in the deep tissues a radiation, the wave length of which is in resonance with the nuclear cancer-producing sensitizer. This is followed by an acceleration of its rate of division which is incompatible with its life. Another method of producing this supersensitization is the intravenous injection of diluted alcohol, as suggested by Thursz. This increases the combustion and, therefore, the mitogenetic radiation in the blood.

J. N. Ané, M.D.

Skin Studies and Clinical Results of the Application of Visible Cold Red Light. H. Cramer and G. Fechner. Strahlentherapie, 1931, XXXIX, 474.

The authors have studied cold red light therapy for several years and believe that it should be used much more in practice. The skin does not show any changes following exposure to this type of radiation. The irradiated skin was studied with the capillary microscope, histologically, and also in connection with histamin and adrenalin injections. The ultra-violet erythema was also used for comparison. The authors believe that visible cold red light is hardly absorbed in the skin but becomes effective in the depths. It differs considerably, then, from the visible heat rays. The clinical results can probably be explained by a non-specific stimulation. Emphasis is laid upon the statement that all cases exposed to this type of light must be treated according to the general medical rules applicable in each respective disease.

Ernst A. Pohle, M.D., Ph.D.

Contribution to the Increase of the Light Erythema by Green Soap. H. Proft. Strahlentherapie, 1931, XL, 351.

The application of green soap to the skin before exposure to ultra-violet light enhances the erythema. The author attempted to find the cause for this effect. It appeared that the increase in the erythema cannot be explained by the presence of a sensitizing dye as, for instance, chlorophyll, nor with a simple swelling of the upper epithelium. Soaking in water and rubbing the skin with cotton slightly increased the erythema. The presence of free alkali appeared to be the most important factor in the enhancing effect. The erythema was decreased by oils and fatty substances. An absolute protection towards ultra-violet light is given by a 10 per cent salicylate alcohol solution. If the upper epithelial layer of the skin of the forearm is removed by shaving and then treated by 0.5 per cent potassium or sodium hydroxid, a spontaneous erythema appears, followed by petechia. Erythema and pigmentation do not run parallel. It is assumed that not only a shifting in the pH is responsible for the increase in the erythema but that an important factor is the influence of alkali-albumin compounds under the influence of the ultra-violet light.

Ernst A. Pohle, M.D., Ph.D.

MIKULICZ'S DISEASE (THERAPY)

Mikulicz's Disease and the Mikulicz Syndrome: Their Treatment by Irradiation. T Leucutia and A. E. Price. Am. Jour. Roentgenol. and Rad. Ther., November, 1930, XXIV, 491.

On the basis of a study of nine cases, the authors believe with other writers, that "the symmetrical enlargements of the lacrymal and one or more pair of the salivary glands," originally described as Mikulicz's disease, should be divided into two main groups: Mikulicz's disease proper and the Mikulicz syndrome. Under Mikulicz's disease proper are included all cases of symmetrical, non-inflammatory swellings of the lacrymal and salivary glands without involvement of the lymphatic system and without alteration of the blood. Under the Mikulicz syndrome are included the cases in which the enlargements of the lacrymal and salivary glands are manifestations of some clinically and pathologically well-defined disease, such as leukemia, tuberculosis, syphilis,

lymphosarcoma, Hodgkin's disease, uveoparotid fever, etc. In the first group, divided doses of irradiation (15 to 50 per cent S.U.D.) are spread over a longer period. This method of treatment has proven more beneficial than the single massive dose as administered in neoplastic processes. In the second group, since the involvement of the lacrymal and salivary glands is merely a manifestation of a more or less distinct clinical entity, a technic should be used which conforms to the routine procedure of irradiation applied in that particular entity. Mikulicz's disease should not be considered an "aleukemic stage" of leukemia, since the average duration of life is longer in Mikulicz's disease, but the disease is somewhat more resistant to irradiation because of the organized structural arrangement of the enlarged glands.

J. E. Habbe, M.D.

RADIUM

A Hypertrophic Response to Radium Irradiation: A Preliminary Communication. Daphne L. Goulston. Med. Jour. Australia, March 21, 1931, I, 335.

The chorio-allantoic membrane of a ten-day chick embryo was exposed by making a window in the shell, according to Moppett's method described in a previous abstract. This membrane has the three embryonic cell layers, ectoderm, mesoderm, and endoderm, conveniently growing together, so that reactions to radiation on each of these embryonic structures may be observed simultaneously.

Radium tubes with active lengths of 1 cm., with 0.5 mm. gold-platinum or 0.5 mm. platinum filter, containing from 2 to 5 mg. of radium element, were laid across the window without actually touching the membrane. After irradiation from 2 to 5 hours and subsequent incubation for three days, macroscopical examination of the membrane revealed irregular thickenings. Microscopically, specimens which received sufficient irradiation showed marked hypertrophy of the mesenchyme. With larger doses, the hemopoietic foci were seen to be in an active state of division, and considerable multiplication of the ectodermal epithelium was evident. Still larger doses produced changes in all three embryonic layers, while, in addition, the proliferating endodermal epithelium formed a papillomatous growth.

Striking photographs of these appearances are reproduced. The miniature cauliflower tumors formed would seem to afford undoubted evidence of a hypertrophic reaction to radiation, and, therefore, of a stimulating effect of the rays.

J. G. Stephens, M.D.

Laryngeal Malignant Disease and Radium. F. Holt Diggle and E. S. Burt Hamilton. Jour. Laryngol. and Otol., January, 1931, XLVI, 37.

Four cases of laryngeal malignant disease treated by radium, with fenestration of the thyroid cartilage, are reported. The early effects of the treatment were very encouraging but there was recurrence in each case. Radium emanation was administered, and, to allow for the loss of potency, a greater initial dose was used. The authors ask whether this dose was excessive, too large and spread over too short a period, or if the treatment by emanation is quite unsuitable in these cases. It is apparent, in any event, that the closest co-operation between the laryngologist and the allied scientists is necessary if progress and not unearned disrepute is to be achieved.

Exposure of Tissue Cells *in Vitro* to Mesothorium. Albert Fischer. Strahlentherapie, 1931, XL, 54.

This extensive research was undertaken in order to study the phenomenon of the "latent period" observed following exposure to roentgen or radium rays. The experiments were conducted on tissue cultures of osteoblasts and fibroblasts of the chicken heart. The technic corresponded to that described by Hans Laser and Ludwig Halberstaedter (*Zeitschrift für Krebsforschung,* June 7, 1929, XXIX, 411). The results are expressed in numerous graphs.

It is concluded that the effect of radium on tissue cells *in vitro* manifests itself by an inhibition in growth. This appears only after

a certain time following the exposure. An analysis of the factors responsible for the latent time shows that the inhibition in growth is partly due to the formation of toxic substances following tissue necrosis. Irradiated tissue cells liberate substances inhibiting the growth of normal cells. The duration of the latent time does not vary much; it is dependent upon the intensity of the irradiation. Injured cells have a shorter latent time. Mitosis does not influence the latent time and the absolute effect of radiation was the same whether the proliferation of the cells was slow or fast. The law of Bunsen-Rosco, which holds for photochemical reaction, is invalid for the biologic effect of radium rays.

ERNST A. POHLE, M.D., Ph.D.

Epithelioma of the Penis Treated by Radium. W. Maxwell and H. M. Moran. Med. Jour. Australia, April 4, 1931, I, 409.

Only a single case is described in which a mild chronic balanitis, with tight redundant prepuce, developed into a granulomatous thickening of the prepuce and an indurated cauliflower tumor about 1 cm. in diameter. The diagnosis of squamous-cell carcinoma was confirmed by biopsy. The glands in the groin were palpable but were thought to be normal or mildly inflammatory.

A mould of Colombia paste was made to ensheath the entire length of the penis. Thirty-five milligrams of radium element in seven foci were disposed around the circumference of the mould, with a filtration of 0.5 mm. of platinum. The testes were protected with lead sheeting. The appreciation of the value of the time factor in the treatment of squamous epithelioma renders a minimum exposure time of four days desirable, and in the present case applications were made for ten hours daily over a period of eighteen days. The radium reaction disappeared at the end of six weeks and the epithelioma at the end of three weeks.

The glands of the groin received no treatment, and after fifteen months there is no sign of metastases. The authors recommend, however, that suspicion of glandular masses demand surgical excision, followed by deep X-radiation or by radium application at a distance.

J. G. STEPHENS, M.D.

The Order of Magnitude of the External Photo-electric Effect of the Human Body and its Dependence upon the Spectral Distribution of the Radium. W. A. Kartschagin and G. S. Warschawer. Strahlentherapie, 1931, XL, 174.

The authors worked out a method permitting the measurement of the photo-electric effect of the human body upon being exposed to a quartz mercury vapor lamp. If the emitted radiation was filtered through ordinary glass, no photo-electric effect could be recorded. A very slight effect was noticeable if the radiation was filtered through blue uviol glass. If the entire emission of the quartz mercury vapor lamp was used, the photo-electric effect of the skin amounted to about 0.65 of the photo-electric effect of iron exposed under the same conditions. The same experiment carried out with radiation filtered through blue uviol glass changes this factor to 0.51. The photo-electric effect of iron following exposure to radiation filtered through uviol glass is only 0.017 of the effect obtained with unfiltered radiation from the quartz mercury vapor lamp. Figures are also given for a comparison of the photo-electric effects measured under varied experimental conditions.

ERNST A. POHLE, M.D., Ph.D.

Radium Therapy. J. H. Montgomery. China Med. Jour., February, 1931, XLV, 101.

The author's interest in radium began with his dissatisfaction with the results of surgery in the treatment of cancer among the Chinese (Matilda Hospital, Hongkong). He tried lead first but never saw much benefit to the disease locally, although there was subjective improvement, and soon gave up the method because of production of anemia and kidney lesions. He began to use radium and became optimistic as to its possibilities, and obtained permission to study its use in Japan, America, England, Scotland, Ireland, and Germany.

The American school, as a whole, is more

inclined to give larger doses over a shorter period than the British and Continental schools, which give smaller doses over longer periods; at the Mayo Clinic, however, they believe the latter more effective and less dangerous than the former—which the author thinks is becoming an almost universally accepted view. He mentions that Kelly is said to possess more radium than anyone else, and extols his work. He saw case after case apparently cured by Kelly's method, with no mutilation and very little scarring, and is convinced that radium, combined with deep X-ray, gives results that surpass the best surgery.

In England, the Radium Institute in London now has a standard course in radium therapy, the clinical and practical work being done at Mount Vernon Hospital, a very large institution devoted entirely to cancer. Marie Curie Hospital, London, is unique, conducted entirely by women doctors; it treats only cases of uterine cancer. The author found the work there "nothing short of miraculous": large carcinomas of the cervix sometimes cleared up in from 2 to 3 weeks, while early cases seemed to disappear almost with one treatment. They use for cancer of the body, 75 mg.-mins. radium element enclosed in 0.50 mm. platinum needle, again enclosed in a small pure vegetable rubber catheter end. At the same time they use a small bomb-like applicator for the vagina with 50 mg.-mins. radium screened with 0.50 mm. platinum, 1 mm. lead, and 1 cm. rubber. These are generally left in position for 22 hours; three treatments are given at intervals of one week. If the cervix is the site of the disease, they reverse the amount of radium, putting 50 mg.-mins. into the uterus and 75 mg.-mins. into the vagina. Since the adoption of this method, they have had no cases of vesicovaginal or rectovaginal fistula. Their full statistics will be published soon. Montgomery's impression is that they are better than Schmitz'. Birkett's work (Manchester) on cancer of the tongue is as good, if not better, than work done elsewhere. He also has excellent results with rodent ulcers, and although the X-ray, as a rule, can cure these cases, with radium there is less danger of a scar—he uses platinum screening chiefly, as it is safest and best.

A new rule in Paris made it impossible for the author to see the work done there, as one must attend a six-months course or remain only 24 hours, during which time one sees only the preparation of radon seeds, radium tubes, and needles, but no clinical work. In Berlin, they too combine the X-ray and radium, but are somewhat limited in research and clinical work by insufficient amounts of radium.

In breast cancer, the general impression gathered is that operation is better in early cases, to be followed by needling or irradiation from Colombia paste mold. Advanced inoperable cases are often made operable by irradiation, recurrences being best treated with radium only. In cancer of the stomach, intestines, kidney, pancreas, and spleen, surgery still holds the field, but the author is hopeful of the devising of new radium methods to deal with these localizations—perhaps through the radium bomb. For cancer of the face, tonsil, tongue, soft palate, and larynx, radium gives far better results than surgery. "By no means is radium a cure for all cases, yet fatalities and recurrences are not the fault of the radium, but occur because of the difficulty of giving a lethal dose to the cancer cells without destroying the healthy tissues."

ROENTGENOTHERAPY

Roentgen Therapy of Spondyloarthritis Deformans. Sepp Grauer. Schweiz. med. Wchnschr., Feb. 14, 1931, LXI, 151-154.

Spondyloarthritis is found in 3.5 per cent of all roentgen examinations of the spine, according to Pokrovskyi. The author feels that this percentage is not excessive. Of 170 cases, 71 per cent were males and 29 per cent females. Most of the male patients performed severe manual labor. The age distribution was from 35 to 70 years. The changes are most marked at the junction of a relatively stable portion of the spine with a sector which is exposed to free motion, *i.e.*, the dorso-lumbar or lumbo-sacral junction.

A description of the typical roentgenologic picture is given, as well as a discussion of the clinical picture. The factors of irradiation

are: Focal skin distance, 30 cm.; filtration, 0.3 mm. zinc and 2 mm. aluminum; fundamental wave length 0.1 Ångström. A dosage of 6 H is given, using an anterior port from 4 to 6 cm. wide, covering the involved area. This is repeated three times, at intervals of seven days. The patients may be divided into two classes: Those who note an immediate response, and those who are improved only after an interval of several weeks. The improvement consists of relief of pain and increased mobility.

H. C. Ochsner, M.D.

The Prevention of Keloids by Prophylactic Roentgen Treatment Immediately after Operation. Martin Bab. Deutsche med. Wchnschr., Feb. 20, 1931, LVII, 319.

In order to prevent keloid formation after cosmetic operations, the author irradiated the wounds 12 hours post-operatively. One-third E.D. (quality not given) was applied, and the same dose was repeated three days later. The histories of two patients are briefly related, both of whom developed keloids following former operations. No keloids developed after the use of prophylactic roentgen treatment following re-operation.

Ernst A. Pohle, M.D., Ph.D.

Therapy in Sleeplessness. Heinrich Uiberall. Med. Klinik, March 27, 1931, XXVII, 465.

The results of trying to influence certain types of sleeplessness (agrypnias) by roentgenotherapy are reported. One must differentiate between two types: (1) The primary agrypnia, which is probably caused by disturbances in the regulatory center, situated in the basal portion of the brain, and (2) secondary agrypnia. It is known that, for instance, an encephalitis lethargica may bring about pathologic changes in this "sleep center." These cases of primary agrypnia are encountered fairly often, as the results of the treatments may indicate. Thirty cases of sleeplessness were treated in the Neurologic Department of "Spitales der Israelitischen Kultusgemeinde," in Vienna. Nine of these belonged to the secondary type and showed no change, and 21 were of the primary agrypnia. In 10 of these latter, a full success could be achieved, 4 cases showed improvement, 3 questionable improvement, and 4 showed no result. Some of these cases were observed for 2½ years.

The technic used was as follows: Single doses of about ⅓ skin erythema dose, with a filter of 0.5 mm. Zn, 170 K.V., 30 cm. focal skin distance through three fields (6 × 6 cm.); two of them through the temples and one through the middle of the forehead. The interval was from 2 to 4 days, and the whole series was repeated after 3 or 4 weeks. The rays were directed toward the hypophysis. The results of this treatment in cases of primary agrypnia seem to promise well enough to justify the treatment in selected cases.

H. W. Hefke, M.D.

The Influence on Medical Thought and Practice of the Progress Made in Modern Roentgenotherapy. Hans Holfelder. Deutsche med. Wchnschr., Jan. 9, 1931, LVII, 47.

The author analyzes the present situation in Germany concerning the training of roentgenologists, and emphasizes the importance of the creation of chairs of clinical roentgenology in all universities. He feels that this would help materially in changing the skeptical attitude of the medical profession toward radiation therapy.

Ernst A. Pohle, M.D., Ph.D.

Pigmentary Reaction in *Rana Clamitans* Larvæ Following Treatments with X-rays. William T. Levine. Proc. Soc. Exper. Biol. and Med., March, 1931, XXVIII, 594.

The author described two stages of the pigmentary reaction in tadpoles following X-ray treatment. Ten tadpoles were given eight treatments of 92 K.V., 5 ma., at a distance of 10 inches from the cathode, for 10 minutes, every other day. Six days after the last treatment the animals were killed and sections made. Near the end of the treatment it was noted macroscopically that the previously

round pigment dots became streaky or comma-shaped, and converged towards one or several centers, located usually in the scapula and the pelvic regions. A hyperplastic rise of the epidermis was observed in these regions. This was followed by a perforation in the center, plugged with a blood clot. Sections and whole mounts revealed that the formerly irregularly placed epidermal melanophores had arranged themselves in one direction, apparently making use of ameboid movement to approach the region of injury. In this area, however, they were found contracted and broken up into many black droplets.

Another group of ten tadpoles was exposed on two consecutive days for 45 minutes to 125 K.V., and 5 ma., at a distance of 10 inches. After the second day the epidermis began sloughing off and the stratum corium was exposed.

J. N. Ané, M.D.

What is the Value of Roentgenotherapy in the Sterilization of Diphtheria Bacillus Carriers? Rudolf Wahl. Deutsche med. Wchnschr., Feb. 13, 1931, LVII, 276.

One hundred and thirty-six bacillus carriers (133 diphtheria, 1 streptococcus, and 2 meningococcus) were treated by roentgen rays. The first dose amounted to a 30 per cent E.D., and the second or third to a 10 per cent E.D. Babies received only half of this amount. One hundred and five cases were free after one exposure, 28 after two exposures, and 2 after three exposures. One remained positive even after the third exposure. Later examinations were returned, however, as negative. In view of these excellent results, roentgenotherapy is recommended in the treatment of bacillus carriers.

Ernst A. Pohle, M.D., Ph.D.

Roentgen Therapy of Psoriasis: A Source of Danger for Physicians and Patients. Karl Hoede. Deutsche med. Wchnschr., April 3, 1931, LVII, 581.

Psoriasis cannot be cured by roentgen rays, and it is dangerous to continue the treatment over too long a period. High doses do not give better results than very conservative doses. Other remedies, for instance, ointments and ultra-violet radiation, should first be given a thorough trial before considering roentgenotherapy. It is unwise to exceed doses of from 25 to 100 r in one sitting. They may be repeated two or three times at intervals of four weeks. One should not administer more than one E.D. per year per area. The records of medico-legal cases bear out these statements.

Ernst A. Pohle, M.D., Ph.D.

The Present Status of Treatment of von Recklinghausen's Disease (Osteodystrophia Fibrosa). F. Mandl. Wien. klin. Wchnschr., March 13, 1931, XLIV, 360.

The following course of treatment seems to be indicated in von Recklinghausen's disease (localized form): If the disease is limited to a rather small area and is benign, from the roentgenologic standpoint—incision and curettement; if larger areas are attacked and a sarcoma cannot be excluded—resection of a portion of the bone, with a bone graft; post-operative—roentgenotherapy. Repeated roentgenologic examinations should be made to exclude malignant degeneration. As to the generalized form, treatment is surgical as related to the parathyroids. If changes in the calcium metabolism are present, a tumor of the parathyroids should be searched for, possibly supplemented by surgical removal of the tumor or of one normal parathyroid followed by roentgenotherapy to the diseased portions of the bones.

H. W. Hefke, M.D.

Experimental Foundations of Roentgen Therapy in Inflammatory Processes. F. Freund. Strahlentherapie, 1931, XL, 333.

Based on experimental work concerning the effect of roentgen rays on the healing of wounds, the author relates his conception of the influence of roentgen rays on inflammatory processes. He believes that an increased transparency of the blood vessel walls is an important factor. An erythema dose up to 75 per cent may be given, according to Freund.

in chronic inflammations to bring about complete regression of the "inflammation cells." Highly filtered radiation of short wave length is most effective. Even after healing has apparently occurred, additional treatment, with from 40 to 50 per cent E.D. one month later, seems advisable to assure permanent cure.

ERNST A. POHLE, M.D., Ph.D.

Changes of the Biologic Properties of Membranes under the Influence of X-rays. Erwin Saxe. Strahlentherapie, 1931, XL, 125.

The author studied the influence of roentgen rays on membranes. Following exposure to 3,000 r, the diffusion velocity was definitely reduced, as compared with an unexposed control. For a lower dose (2,000 r), the effect was still present, but to a lesser degree. These observations open very interesting possibilities for experiments on biologic objects.

ERNST A. POHLE, M.D., Ph.D.

Our Experience with Roentgenotherapy in Hypertrophy of the Prostate. H. Boit. Deutsche med. Wchnschr., Feb. 27, 1931, LVII, 351.

In this article, the author analyzes 114 cases of adenoma of the prostate which have undergone roentgenotherapy. They were not selected: 8 belonged to the first stage, 22 to the second stage, 6 had acute retention, and 78 belonged to the third stage. On three successive days, three fields of 6 × 8 cm. were given over the anterior and posterior pelvis and over the perineum (185 K.V., 4 ma., 0.5 Zn + 1.0 Al). The dose per area amounted to 80 per cent E.D., which led to a dose of about 94 per cent effective in the prostate. The testicles were protected. Shortly before each treatment, the bladder was emptied, washed with boric acid solution, an enema was given, and 10 c.c. of a 50 per cent glucose solution was injected intravenously. If necessary, the treatment was repeated at intervals of four weeks.

Of the 114 patients, 10 died during the treatment from other diseases, 91 became free of symptoms and had no retention. Among these were all of the 8 patients belonging to the first stage and all of the 6 having acute retention. Six cases were improved, having a retention of from 10 to 200 cubic centimeters. There were 7 which did not improve. Among the improved patients, there were 2 and among the unimproved, 3 who returned for further treatment. Several of the unimproved cases had, in all probability, a carcinoma; this was proved in one case on which an autopsy was performed later. Fifty-one cases could be followed up by letter, and 35 were examined one to five years after the treatment. This leaves a total of 86 patients for an evaluation of the results. Twenty-eight of the 51 traced patients had died, and 23 were alive at the time of the inquiry. Eleven patients had died from other diseases, 12 from complications of the prostatic disease, and 5 from unknown causes. Of the 23 living cases, the bladder function was good in 15, satisfactory in 5, and poor in 3. Of the 35 examined patients, 19 had no retention, 16 showed a retention of from 10 to 95 c.c., but were, however, satisfied. Expressed in percentages, this would mean that in more than 50 per cent of all cases the result was good one to five years after the treatment. About 25 per cent were in satisfactory condition, and in the remaining 25 per cent the result was poor. In 30 per cent of the patients, a recurrence took place; about one-third of these responded, however, to additional treatment.

Too many repetitions of the treatment must, however, be avoided, since this may lead to a fibrosis of the pars prostatica, causing the same symptoms as a stricture. Of all patients discharged without symptoms and without retention, 32 remained well longer than one year; of these, 13 were well for 1 or 2 years, 9 for 2 or 3 years, 8 for 3 or 4 years, and 2 for 4 or 5 years. The therapeutic effect of the treatment on the amount of retention does not manifest itself before from 10 to 14 days after the exposure.

The author concludes that roentgenotherapy, with relatively high doses, is the method of choice in inoperable cases of adenoma of the prostate. In the operable cases of the second and third stages, prostatectomy is preferable. If operation is refused, radiation ther-

apy usually offers good results. This may be improved by further development of the treatment technic. Not more than four or five series should be given, because of the danger of fibrosis in the pars prostatica.

ERNST A. POHLE, M.D., Ph.D.

SINUSES (DIAGNOSIS)

Chronic Infections of the Maxillary Antra in Systemic Disease: A Radiological Study. G. E. Richards. British Jour. Radiol., March, 1931, IV, 120.

For the detection of the less marked pathologic changes in the muco-periosteum of the maxillary sinuses, the technical quality of the films must be of the highest, and even then "plain" films may not clearly show the changes. Quantities of viscoid material, certain small cysts, and slight degrees of inflammatory thickening may be present and be productive of symptoms, yet defy detection by any ordinary examination, either clinical or roentgenologic, except by radiographic study after the injection of the sinus with some contrast medium, such as lipiodol, diluted to one part in four of olive oil. For proper filling and the avoidance of pseudo-filling defects, it is necessary to anesthetize the nose and puncture the antrum with a small trochar, through which sufficient oil is injected completely to fill and overflow the sinus. Ordinarily, the two antra are injected and studied simultaneously.

In the normal antrum the filling is, as a rule, quite smooth, although, occasionally, anatomical irregularities or bony septa are found. A number of patients with either localized or more generalized tissue hyperplasia within the antrum have shown prompt relief from asthmatic attacks, recurrent colds, bronchitis, and low-grade pyrexia upon radical removal of the chronically infected tissue in the walls of the diseased sinus. The author feels justified, on this basis, in advocating the contrast-film examination, even in the presence of a "dry tap" by the rhinologist and essentially negative sinus films by the plain film method.

J. E. HABBE, M.D.

Roentgenologic Diagnosis in the Field of Oto-rhino-laryngology. E. Wirth. Röntgenpraxis, March 15, 1931, III, 241.

The roentgenologic examination has developed into a valuable and sometimes necessary diagnostic means for otology and rhinology, but not so much for laryngology. From the roentgenologic examination alone, however, a correct diagnosis can be made in only very few cases, and should be considered only a valuable aid to the other clinical methods of examination. One thousand five hundred forty roentgenologic examinations of sinuses and 660 examinations of the mastoids were made in one year, about every fourth patient being subjected to the X-ray examination in the clinic. This number shows that the roentgenologic examination is of definite value in this specialty. The technic and the reading of the films are difficult, especially of the mastoids. An extensive experience is necessary to evaluate slight changes from the normal in mastoid and sinus films. Really, the clinician can acquire the experience only when he does the technical work and the interpretation himself. He alone can follow up the cases and compare the roentgenologic findings with the clinical picture and the operative findings. Interpretation of complicated films of mastoids and sinuses would be very difficult for a roentgenologist who has had no special experience in otology and rhinology. In this field, close co-operation between the roentgenologist and the clinician is absolutely necessary.

H. W. HEFKE, M.D.

SKIN (THERAPY)

The Radiotherapeutic Treatment of Cutaneous Epitheliomas. J. Laborderie. Arch. d'Électricité Méd., March-April, 1930, XXXVIII, 145.

It is believed that radiotherapy is preferable to surgery in the treatment of cutaneous epitheliomas, because of the necessity of radical operation and subsequent mutilation and scarring in the latter. In the application of radiotherapy, however, the author believes, as

does Regaud, that a malignant tumor should be completely destroyed by the first application, and if this does not occur it will become more malignant. Broca administered at one application from 20 to 30 H, without filtration, and claimed that this massive dose had never produced a dermatitis, provided care was taken to protect the normal skin. The author believes that the rays of moderate wave length are sufficient to kill all the cancer cells if the dose given is large enough. The more penetrating rays are not only useless but also dangerous because of their effect on the deeper organs.

He reports a series of 40 cases of cutaneous epitheliomas treated by the X-ray, in which all but 2 patients were cured by a single application. His technic consisted of a single application of 110 K.V. (maximum), at 3 ma., without filtration. It was determined by the ionometer that a dose sufficient to kill cancer cells was obtained in about 25 minutes, with the above technic. Using a pastille of the chromoradiometer of Bordier, near the lesion, tint IV resulted in about 25 minutes.

In from 8 to 13 days the patient experienced more or less itching, and a serous exudation occurred, which formed a crust. Later, the odor and exudation disappeared, and after a time a white smooth scar replaced the ulcerated area. Antiseptic precautions should be used during this interval. Magnesium chloride was found helpful to facilitate the elimination of the slough, which should not be removed by traction.

J. N. Ané, M.D.

Late Injuries Following Roentgen Treatment of Skin Diseases and Conclusions Concerning the Technic. H. Fuhs and J. Konrad. Strahlentherapie, 1931, XL, 254.

In 9,293 cases treated by roentgen rays for some skin disease, a total of thirty-three late reactions were observed. They are distributed, according to disease, as follows: Acne vulgaris (2), condyloma acuminatum (1), eczema chronicum (3), eczema seborrhoicum capitis (1), epilation (microsporon, trichophyton, favus) (8), erythema induratum exulceratum (1), hypertrichosis (2), keratosen (arsen) (1), lupus vulgaris (3), morbus Bowen (1), psoriasis vulgaris (3), skrophuloderm (3), tuberculosis verrucosa cutis (3), verrucæ vulgaris (1).

The authors analyzed each case in detail in order to determine the possible cause for the observed injury. Certain precautions are suggested to prevent such undesirable results in the future, even though the percentage of late reactions must be considered very small. In children below 4 years of age, for instance, the authors do not epilate any more. In psoriasis, roentgen rays should be used only when all other means have been exhausted, and then only in doses of from 50 to 100 r, given once or twice. Eczema must also be treated with conservative doses, particularly should the intervals between series be sufficiently long. Caution is also indicated in skin tuberculosis. For warts, doses of from 200 to 300 r (0.5 to 4.0 Al), depending on the type of lesion present, will be sufficient. The treatment should not be repeated before six or eight weeks.

In view of the valuable data presented in this paper it is recommended for study in the original.

Ernst A. Pohle, M.D., Ph.D.

Ten Years' Experience in the Treatment of Psoriasis by Thymus Exposure. C. Speierer. Strahlentherapie, 1931, XL, 272.

An analysis of 50 cases of psoriasis, treated by roentgen exposure of the thymus, revealed that in not a single case could a permanent cure be obtained. In a few patients, temporary disappearance of the lesions was seen. Recurrence took place, however, within a year. It was striking that mostly young patients responded to the thymus treatment; there existed apparently no difference between the two sexes. A change in the technic did not alter the results. Therefore, Brock's original procedure was adopted (50 per cent E.D., 3 mm. Al for adults, and from 25 to 33 per cent E.D. for children; moderate penetration).

As it is known that the thymus decreases promptly in size after the application of even

very small doses of roentgen rays, the author believes that the theory of a stimulation effect on the thymus cannot be upheld. He feels that there may be a connection between psoriasis and tuberculosis. The beneficial results following exposure over the upper mediastinum could be due to an effect upon the glands in that region, since it is well known that tuberculous glands usually respond to roentgen treatment.

ERNST A. POHLE, M.D., Ph.D.

Seventh International Congress of Dermatology and Syphilography, Copenhagen, August 5–9, 1930. G. Solente. Ann. de derm. et syph., Paris, 1931, II, Ser. 7, 1.

The author has made a review of all the papers presented at the last Congress of Dermatology and Syphilography. In studying "Cutaneous Tuberculosis and its Treatment," a number of papers were presented which mentioned the use of various types of light therapy (Finsen, voltaic arc, Kromayer lamp, ultra-violet, radiotherapy, Duflot-Dufestel lamp, etc.), including the following:

Treatment of Tuberculosis of the Skin. Axel Reyn. (Pages 75–79.)

Treatment of Lupus Vulgaris (Traitement du lupus vulgaire). Paul Francois. (Pages 82, 83.)

Cutaneous Tuberculosis. R. Volk. (Pages 84, 85.)

Lupus Vulgaris. Porcelli. (Page 95.)

Local Treatment of Lupus (Traitement locale du lupus). Marceron. (Page 95.)

Treatment of Cutaneous Tuberculous Lupus (Traitement du lupus tuberculeux cutane). Jausion. (Page 102.)

Radiotherapy by Coste's Method (Only One Sitting, Short Wave Length, No Filtration) in the Treatment of Certain Types of Cutaneous Tuberculosis (Radiotherapie selon la methode de Coste—seance unique, courte longueur d'ondes, pas de filtration). Nicolas, Gate, Coste, and Michel. (Page 103.)

Treatment of Lupus by Subcutaneous Radium (Traitement du lupus par le radium souscutane). Th. Behaegel. (Page 103.)

Pigment and Protection against Light (Pigment et protection contre la lumiere). Ph. Keller. (Page 123.)

Rational Cutaneous Therapeutics with Limit Rays (Therapeutique cutanee rationnelle par les rayons limite). G. Bucky. (Pages 123–125.)

Use of Limit Rays in Dermatology (L'emploi des rayons limite dans la dermatologie). A. Kissmeyer. (Page 125.)

Present State of Dosimetry in Dermatology (Situation de la dosimetrie dans la dermatologie. Schreus. (Page 125.)

Irradiation of the Thyroid in Diseases of the Skin (Irradiation de la thyroide dans les maladies de peau). Julius Samek. (Page 125.)

Radiographic Picture of the Posterior Urethra in Gonorrhea (L'image radiographique de l'urethre posterieur dans la gonorrhee). Richard Fruhwald. (Page 126.)

SKULL (DIAGNOSIS)

Schilder's Encephalitis Periaxialis Diffusa: Report of a Case in a Child Aged Sixteen and One-half Months. Myrtelle M. Canavan. Arch. Neurol. and Psychiat., February, 1931, XXV, 299.

The author gives a detailed report of a case affected with this disease. It is characterized pathologically by degeneration of the white matter in the brain, and there may be evidences of scavenger cells and also an increase of glia and edema of the white matter near the cortex. This disease is of interest to the roentgenologist because it may produce evidences of increased intracranial pressure on the roentgenogram.

Incidentally, the disease was first described by Schilder of Vienna, in 1912, and only twenty-eight cases had been reported up to July 1, 1929.

C. G. DYKE, M.D.

The Technic of Encephalography. Carl D. Camp and R. W. Waggoner. Arch. Neurol. and Psychiat., January, 1931, XXV, 128-136.

Encephalography as a diagnostic procedure is well recognized. It has also been suggested

and frequently used as a therapeutic measure. The two objections to such use are: (1) The severe reaction which the patient experiences during and after the injection of air, and (2) its danger to patients who show much increase in intracranial pressure, especially in the presence of choked discs, tumors of the brain, and particularly lesions of the posterior fossa.

Since, to some extent, the distress of the patient is in proportion to the amount of movement to which he is subjected, a chair has been constructed in which the patient may be placed before the procedure and in which he may remain until he is returned to his bed. The puncture may be done with the patient in the prone or upright position in the chair. In either case, he is seated for the injection of air.

A second device which has been of great assistance is a special X-ray tube and Bucky diaphragm stand. This stand makes possible a constant X-ray technic which not only facilitates the mechanical part of the procedure, but also standardizes the films by making the relation of the patient's head, the X-ray tube, and the film constant, thus making interpretation much easier.

Roentgen Diagnosis of Disease at the Base of the Skull. R. Pomeranz. Arch. Otolaryngol., January, 1931, XIII, 63.

The roentgen diagnosis of intracranial disease is one of the most difficult chapters in diagnosis. One of the most prominent of the recent workers in this field is E. G. Mayer, assistant to Professor Holzknecht in Vienna. He not only has introduced new positions in the technic, but also has achieved remarkable results in the interpretation. The author considers as ideal the combination of an exceptionally large clinical and roentgenologic knowledge, which, however, is rare. A happy medium for the average physician would be the co-operation of the clinician with the roentgenologist, both before and after the roentgenologic examination.

Our task is to further the diagnosis of intracranial basal or near-basal tumors by visualization and proper interpretation of the bony changes of the skull, particularly of the base of the skull and of the sinuses. For a good general survey of the main structures at the base of the skull, two views are necessary, namely, frontal and sagittal. Of the numerous special views cited, three are particularly important: (1) Axial view of the middle fossa (Schüller), taken in the submentobregmatic direction, if possible: (2) the Stenvers view of the pyramis; (3) oblique view of the orbit by Rhese as modified by Goalwin, visualizing the optic canal, which is of diagnostic value only in selected cases. The author does not believe it advisable, for several reasons, to use the Bucky diaphragm in the diagnosis of diseases of the skull; it is also not advisable to use large distances and large cones in this work.

He then discusses the roentgenologic differentiation of various pathologic changes at the base of the skull: increased endocranial pressure; sellar erosions; changes in the body and wings of the sphenoidal bone; pathologic changes in the pyramids—mastoid portion and rest of the pyramids; inflammatory changes of the mastoid; cholesteatomas; tumors of pyramidal eminence; sinus involvements from various causes, and basal injuries (fissure fractures).

SKULL (THERAPY)

Modern Treatment of Increased Intracranial Pressure. Foster Kennedy and S. Bernard Wortis. Jour. Am. Med. Assn., April 18, 1931, XCVI, 1284-1286.

A clearly formulated plan of treatment could be solved only by the proper application of exact physiologic knowledge regarding intracranial pressure changes brought about by protean factors, such as sleep-waking, changes in posture, respiratory variations, and the exact effects of many different drugs.

Extensive experiments were carried out on patients having bone defects in the skull, beneath which defects the dura had been cut and left unsutured. Pressure conditions inside the skull were transmitted by tambour to a pointer recording on a revolving drum. The results germane to this discussion were as follows:

Sleep is accompanied by an increase of intracranial pressure; the act of wakening is coincident with a decrease of this pressure; morphine, glyceryl trinitrate, hypotonic solutions, and the assumption of the horizontal position all cause heightened pressure within the skull. This was true also as regards coughing, stool straining, struggling, and ether anesthesia. On the other hand, intracranial pressure was invariably reduced by raising the head above the level of the heart. Caffeine sodio-benzoate given below the skin or into a vein reduced intracranial pressure promptly. The same was true of hypertonic solutions, periodically sustained deep breathing, and the removal of cerebrospinal fluid by the lumbar route.

The causes of increased intracranial pressure in the order of their frequency are: (1) Skull fracture; (2) brain tumor; (3) meningitis; (4) cerebral hemorrhage and thrombosis; (5) subarachnoid hemorrhage; (6) hydrocephalus due to inflammation around ventricular foramina; (7) hypertension associated with headache, and (8) acute cerebral edema.

The major operations should not be resorted to until all the other procedures have proved futile and incapable of arresting steadily increasing pressure within the skull.

CHARLES G. SUTHERLAND, M.D.

Management of Head Injuries. L. D. McGuire. Nebraska St. Med. Jour., November, 1930, XV, 427.

The only cases of acute head injuries which should be taken immediately to the operating room are those with severe scalp lacerations and open vessels, or those with markedly depressed skull fracture. Most of the head injuries should be rushed to bed and not to the operating room. Cases of concussion should have three weeks in bed as a minimum, for concussion means an actual head injury. Only rarely is a skull fracture of serious moment, and the essential treatment is that of the profound shock; the determination of the presence or absence of skull fracture is of secondary importance. After the patient has recovered from shock, he may have X-ray examination for possible fractures of the skull.

W. W. WATKINS, M.D.

SPINE (DIAGNOSIS)

A Peculiar Type of Vertebral Synostosis in a Kyphosis of Adolescent Age. Kurt Lindemann. Röntgenpraxis, March 15, 1931, III, 267.

In a fifteen-year-old girl, a fixed dorsal kyphosis developed gradually from a static kyphosis of the adolescent type. Roentgenologic examinations were made during the progress of the disease, which showed narrowing of the intervertebral discs, irregularities in the structure of the enchondral growth zones of the vertebræ, and increased density in the anterior parts of the discs. This chronic and symptomless process led finally to a partial synostosis of some of the vertebræ. The differential diagnosis is given in detail, and a congenital etiology is denied by the author. One deals either with changes caused by the adolescent type of a kyphosis or with an infectious metastatic process.

H. W. HEFKE, M.D.

Spondylitis Deformans. Samuel Kleinberg. Arch. Surg., March, 1931, XXII, 485.

Spondylitis deformans is a progressive disease of the spine characterized by gradually increasing flexion of the trunk and ankylosis of the vertebræ. The disease usually comes on insidiously but may begin with an attack similar to lumbago. If the patient is seen during the early course of the disease, it will be found that he stands and walks with his head bent forward. The spine is symmetrical but flat. There is definite limitation of motion. If the patient attempts to straighten up, it can be seen that there is very slight motion in the spine itself, but the trunk is hyperextended on the hips.

At first, the X-ray examination of the spine may be entirely negative, or may show marginal lipping or osteophytes. As time goes on, however, there is an increasing ankylosis of the spine until finally the vertebræ all become fused into one mass. The ribs may also be-

come fixed through ankylosis of the costovertebral joints. Breathing is entirely abdominal.

The disease occurs more frequently in males than in females, and usually between the ages of twenty and forty. The author states that the removal of infectious foci, such as diseased tonsils or teeth, does not usually have a beneficial effect on the vertebral lesion.

The local treatment of this condition is concerned first with the correction of the deformity; secondly, with the mobilization of the spine whenever possible, and thirdly, the relief of backache. When the condition of the patient has progressed to the stage of bony ankylosis of the vertebræ, the deformity and disability are permanent and irremediable. In the earlier stages, however, before there is ankylosis, the deformity can often be corrected slowly by treating the patient on a convex frame. Later a brace is applied to maintain the position. Baking and massage are administered during the course of the active treatment on the frame.

HOWARD P. DOUB, M.D.

The Intervertebral Disk. Emil S. Geist. Jour. Am. Med. Assn., May 16, 1931, XCVI, 1676-1679.

Due to Professor Schmorl, of the Dresden Pathologic Institute, an increase in knowledge of pathologic changes in the spine has been acquired in the past five years. He has indicated the anatomy, physiology, and pathologic anatomy of the intervertebral disk. There is not possible a single motion of the spine without the aid of the intervertebral disks.

The disks are intimately attached to the compact bony rim of the vertebral body and loosely to its sieve-like surface. They contain in the adult neither blood vessels nor nerves. A disk is composed of three distinct parts: (1) The nucleus pulposus; (2) the annulus fibrosus, and (3) the cartilage plate ("knorpelplatte," Schmorl).

The microscopic anatomy shows an intricately planned mass of fibrocartilage surrounding the nucleus pulposus with few, if any, elastic fibers. The nucleus pulposus is normally situated slightly behind the median line. It is composed chiefly of the remains of the notochord, a semi-fluid ground substance, débris, and cartilage cells. It is comparatively large in children and recedes in size as age advances. Normally it never disappears.

The annulus fibrosus forms the major portion of the intervertebral disk. It is composed of fibrocartilage and is firmly attached to the cancellous rim of the vertebral body. The cartilage plate is in contact with the surface of the vertebral body, rather loosely attached to the underlying sieve-like surface of the vertebral body, and can be readily detached. Roentgenograms showing notchings in the anterior and posterior surfaces and upper and lower anterior rims are given anatomic explanation.

The function of the disk is discussed in detail. Pathologic conditions of the disk, congenital anomaly, and calcification are rare. Prolapse of the disk was present in 38 per cent of 3,000 autopsies. Where prolapse has existed for some time, new bone may be laid down and is often seen roentgenologically. Chronic spondylitis should be used only to describe an inflammatory process of the body and disk. Arthritis should be reserved to diseases of the posterior intervertebral joints, which are true joints. Conditions in which pathologic conditions of the disk are of a secondary nature, are discussed.

CHARLES G. SUTHERLAND, M.D.

THROAT (DIAGNOSIS)

The Diagnosis of Laryngeal Disease: Laryngoscopic Appearances Correlated with Roentgenologic Observations. Chevalier L. Jackson. Jour. Am. Med. Assn., Nov. 1, 1930, XCV, 1322.

In this essay the laryngoscopic appearances are correlated with the roentgenologic observations. Patients with early and easily operable cancer or incipient tuberculosis may be allowed to go for months without an accurate diagnosis and appropriate treatment through failure to make a careful diagnostic study. A diagnostic study entails (1) a complete history; (2) mirror laryngoscopy; (3) roentgenographic study of the neck and chest

and, in most cases, of the sinuses; (4) complete general physical examination, with particular attention to the chest; (5) blood Wassermann test; (6) sputum analysis; (7) direct laryngoscopy (if indicated), and (8) biopsy (if indicated). A series of case reports stress the characteristics of various types of disease.

The recent work of Pancoast and Pendergrass has developed the roentgenology of the neck to such a degree that the fluoroscopic and roentgenographic study of the larynx itself is of the greatest importance in diagnosis. The author acknowledges the value of fluoroscopic and roentgenographic study of the neck, and states that the roentgenologist can now detect inflammatory and neoplastic processes in their incipience, when they are causing only the mildest symptoms.

C. G. SUTHERLAND, M.D.

THYROID (DIAGNOSIS)

Intrathoracic Goiter. George M. Curtis. Jour. Am. Med. Assn., March 7, 1931, XCVI, 737.

Still too frequently patients are seen with intrathoracic goiter that has escaped recognition even in competent hands. This is due to the fact that a meager symptomatology has not seemed to warrant taking a roentgenogram of the trachea. Since the treatment is essentially surgical, it is of advantage to practise this early before the goiter has become too large, adherent, or even malignant.

Wuhrmann's monograph is still a mine of information for students of this disease. The total or complete intrathoracic forms may occur with or without a cervical goiter. The partial forms seem to be the most confusing since they are intermediate between the deep and the total intrathoracic goiter. They are always accompanied by a cervical goiter, a greater part of which extends into the thoracic cavity and remains there even on swallowing or straining. Those that grow toward the median line and anteriorly are commonly called retrosternal, substernal, median, or mediastinal. Those more lateral in position are designated as lateral, suprapleural, and retroclavicular or, more frequently, subclavicular. The diagnosis of intrathoracic goiter is readily made by the X-ray. Fluoroscopy is of great aid in the differential diagnosis of the intrathoracic tumor. It is generally stated that intrathoracic goiters move on swallowing. Carcinoma with surrounding infiltration, a narrow connecting stalk between the thoracic and cervical goiter and fixation at the inlet, all tend to immobilize the intrathoracic shadow under the fluoroscope. The treatment is essentially surgical.

CHARLES G. SUTHERLAND, M.D.

Hyperthyroidism and Associated Pathology. William Lewis. Am. Jour. Med. Sci., January, 1931, CLXXXI, 65.

This article comprises a study of 12 necropsies on patients who suffered from hyperthyroidism, with all the clinical findings. The author believes that the anatomic changes in the heart and blood vessels are mainly due to coronary sclerosis, arteriosclerosis, or old rheumatic fever. These pathologic changes, when present, are compatible with the age and with each other.

Certain deaths clinically resembling crises or post-operative storms can be ascribed, on pathologic examination, partly or largely to such causes as coronary sclerosis, myocardial failure, or early bronchopneumonia.

No significant anatomic changes were found in the spleen, liver, kidneys, pancreas, adrenals, or ovaries. There was no evidence that hyperthyroidism *per se* has any toxic influence or direct pathologic action on the heart, but, indirectly, it accelerates the development and progress of pathologic lesions from other sources by causing increased work for the heart.

ROE J. MAIER, M.D.

TUBERCULOSIS (DIAGNOSIS)

The Differential Diagnosis between Pulmonary Tuberculosis and Pulmonary or Bronchial Malignant Neoplasms. Channing

Frothingham. Am. Rev. Tuberc., February, 1931, XXIII, 107.

The writer stresses the importance of the differential diagnosis, as in one instance so much can be done, while in the other, little is to be expected from any treatment. Malignant neoplasms of the lung, as found in the Peter Bent Brigham Hospital, show a marked increase. In ten years, from 1913 to 1922, 7 cases were diagnosed; in five years, from 1923 to 1927, 16 cases were diagnosed; in two years, 1928 and 1929, 16 cases were diagnosed.

Examination of clinical histories and laboratory examinations are so varied that the writer frankly states they are of little value other than to suggest "Something unusual is going on." The X-ray examination of the chest is stressed as of tremendous importance, especially serial examinations and re-examination at intervals after X-ray therapy.

Next in importance is the bronchoscopic study, which he finds to be of greatest importance in intrabronchial growths. In metastatic malignant tumors of the lungs, the symptomatology is so varied there is usually nothing that points definitely to the nature of the disease. A series of films showing primary malignancy and metastatic tumors is presented, with a thorough description of the cardinal points in each.

The author arrives at the following conclusions: (1) The physical examination did not show any characteristic signs which were peculiar to malignancy; (2) the clinical pathology was not helpful in making a diagnosis—the blood, sputum, urine, and temperature curves were of no definite value; (3) the diagnosis depends principally on the X-ray findings, although the interpretation at times is difficult; (4) bronchoscopic study of the intrabronchial types at times is positive.

S. C. Barrow, M.D.

The Clinical Classification of Pulmonary Tuberculosis. Sidney J. Shipman. California and Western Med., March, 1931, XXXIV, 172.

The author classifies pulmonary tuberculosis into two groups, namely, proliferative and exudative, but does not make a differentiation which appears to be helpful to the X-ray interpretation.

F. B. Sheldon, M.D.

Tuberculosis of the Stomach: An Analysis of Cases Recently Reviewed. Ralph W. Good. Arch. Surg., March, 1931, XXII, 415.

Tuberculosis of the stomach is a rare disease of adults. The average incidence, as derived from the total number of necropsies, was 0.34 per cent. The symptoms associated with this disease are pain after meals, loss of weight and strength, and vomiting. In half of the cases, tuberculosis is found elsewhere in the body. The disease is often mistaken for gastric ulcer or carcinoma.

The pyloric end of the stomach is the site of predilection. In most instances, the gross appearance of the lesion is not characteristic unless visible tubercles are present. The real diagnosis is revealed only by microscopic examination.

The presence of an organic gastric lesion can be established with relative ease. The treatment is surgical and, by choice, consists of radical resection of the lesion-bearing portion of the stomach. The roentgen findings are usually those of an organic lesion in the antrum of the stomach.

Howard P. Doub, M.D.

TUBERCULOSIS (THERAPY)

Radiation Therapy in the Treatment of Tuberculous Infections. Marcel Ory. Strahlentherapie, 1931, XXXIX, 780.

Tuberculosis is a systemic disease manifesting itself in most cases in local foci. The indications for light therapy vary with the stage of the disease. In the first stage, ultra-violet rays have apparently no effect, since they do not increase the bactericidal qualities of the organism. In the second stage—the congestive period—ultra-violet radiation in erythema doses helps the organism in fighting toxins. During the third stage, or period of sclerosis, the ultra-violet rays have their optimal effect.

It is necessary to continue the treatments for a long time. Although there are no absolute contra-indications, it is necessary to control the temperature of the patient. Those with a tendency to hemorrhage in lung, kidney, or gastro-intestinal tract should not be treated. Tuberculous adenitis and peritonitis, pleuritis, tuberculosis of the small bones, lupus, and tuberculous epididymitis respond best.

ERNST A. POHLE, M.D., Ph.D.

Healing of Tuberculous Cavities. Louis H. Fales and E. A. Beaudet. United States Vet. Bureau Med. Bull., March, 1931, VII, 197.

Contrary to the opinion expressed by others that the presence of cavities in pulmonary tuberculosis gives to the case a rather hopeless outlook, the authors, having studied 147 cavities, are inclined to more optimism. They conclude, however, that the healing depends upon the size of the cavity and the amount of pulmonary involvement.

Their studies are based almost entirely on stereoroentgenograms taken at intervals of three months. The reliability of the X-ray findings has been proven by comparisons of roentgenograms made before and after death, with the postmortem findings. Very rarely, because the cavity wall has not formed or because of absorption and resolution of a thin-walled cavity, a lack of visibility on the roentgenogram has resulted. In this survey, following the work of Bruns, Burnham, and Brown, all annular shadows were considered cavities, unless proven otherwise. While a positive sputum may be present in cavitation, this usually disappears with healing. The physical examination was considered of no value because only 20 per cent of all cavities show the recognized physical signs. With the healing of the cavities, however, there was noted evidence of clinical improvement.

In the healing of cavities, it was noted on the roentgenogram that the annular shadows gradually became smaller and the wall more indistinct. When complete healing occurred, there remained only an area of fibrosis with radiating lines. In some cases it is believed that all traces of the cavity may disappear entirely.

Cavities were classified into small (less than 2.5 cm. in diameter), large (2.5 cm. or over), and multiple. In this series of 147 cavities, 56 were small, 44 large, and 47 multiple. Of this total, 62, or 42 per cent, healed. Of the cavities of all classes which healed or became smaller, 69 per cent were in the right and 83 per cent in the left lung. In bilateral cavitation, healing occurred in both lungs in only 9 per cent of these cases.

In their management it was believed that rest treatment was of greater value than pneumothorax, thoracoplasty, or other surgical procedures. Rest should be prolonged for at least from 12 to 18 months. Then, if the cavities show no evidence of healing, resort may be had to other measures.

J. N. ANÉ, M.D.

The Necessity for Combined Treatment of Glandular Tuberculosis. Kurt Mosdzien. Strahlentherapie, 1931, XXXIX, 507.

A number of cases with tuberculous glands treated by the author responded best to a combination of local X-ray therapy and general light exposure. Deep therapy radiation (from 150 to 190 K.V., copper filter), except for very superficial glands, was used. Treatment was given two or three times, from 10 to 25 per cent E.D. per sitting, with a three or four weeks' interval between the doses.

ERNST A. POHLE, M.D., Ph.D.

Roentgen Therapy in Tuberculous Diseases of the Eye. A. Lorey and K. Mylius. Strahlentherapie, 1930, XXXVIII, 473.

The authors report their results in the treatment of tuberculous affections of the eye, by roentgen rays. They used two types of radiation: 110 K.V., 3.0 or 5.0 mm. Al; 170 K.V., 0.5 mm. Cu+1.0 mm. Al. The single dose amounted to from 50 to 200 r; from 100 to 125 r are recommended for most cases. The treatment should not be repeated before from one to two months, and more than three or four treatments per year are inadvisable. In tuberculosis of the conjunctiva, radium

therapy gives better results than roentgen therapy. Seven milligrams of radium element, filtered through 0.1 mm. Ag and 3½ mg.-hrs. per square centimeter, are suggested. The combination with the cautery gave encouraging results.

Tuberculosis of the cornea was seen in 12 patients; some had been under observation for several years. They seem to respond best to irradiation. In view of the small doses given, there is no danger of an injury to the lens. Twenty cases of iridocyclitis were also seen, but in only two cases could a complete cure be obtained. A number of case histories illustrate the observations. A few cases of tuberculosis of the retina and sclera were also treated by roentgen rays. This small number of cases does not permit, however, any definite statements.

In conclusion, it is suggested that each patient be given a note indicating the dose and quality of radiation received over the eye, in order to prevent additional and excessive treatment in another hospital.

ERNST A. POHLE, M.D., Ph.D.

The Question of Boeck's Sarcoid: A Special Form of Atypical Tuberculosis. J. Michelsen. Deutsche med. Wchnschr., April 3, 1931, LVII, 574.

A case of sarcoid in a 26-year-old girl, with involvement of the lungs, is described. The skin lesions responded to X-ray therapy (40 and 30 per cent E.D., 3 mm. Al). Deep therapy was applied over the lungs (9 fields, 6 × 10 per cent E.D.). Although the blood count improved and the weight increased, there were no definite changes in the lung findings.

A roentgenogram of the chest and a photomicrogram of a skin nodule are appended.

ERNST A. POHLE, M.D., Ph.D.

TUMORS (DIAGNOSIS)

A Contribution to the Lymphogranulomatosis of the Lungs. Walter Kuckuck. Röntgenpraxis, Jan. 15, 1931, III, 79.

The clinical and roentgenologic findings of an atypical case of Hodgkin's disease are described. The roentgenologic examination of the chest showed first a large, round, well circumscribed shadow, with a fluid level in the right lower lobe which impressed one as being metastatic. Later another similar tumor was found in the left upper lobe. An autopsy showed these to be lymphogranulomatous tumors. This type of Hodgkin's disease in the lung is seen very rarely.

H. W. HEFKE, M.D.

On the Essential Principles of Malignancy. A. Dietrich. Strahlentherapie, 1931, XL, 1.

This is a theoretical discussion of malignant tumors from the standpoint of the pathologist. The article is not suitable for abstracting and should be looked up in the original.

ERNST A. POHLE, M.D., Ph.D.

A Case of a Primary Sarcoma of the Lung in an Infant Twenty-nine Months of Age. Philip Rosenblum and Benj. Gasul. Arch. Pediatrics, January, 1931, XLVIII, 63.

A review of the medical literature reveals only two cases of primary sarcoma of the lung in infants. Roentgenologic and pathologic examinations of one case disclosed a huge tumor of the right lung, which displaced the heart and mediastium to the left. Histologically, it was sarcoma.

E. C. VOGT, M.D.

Intrathoracic Neurofibromas and Their Differential Diagnosis. Thomas Canigiani. Röntgenpraxis, March 1, 1931, III, 214.

The roentgenologic differential diagnosis of intrathoracic neurofibromas is very difficult. Such a case is described in detail. The roentgenologic examination showed an intrathoracic mass which was in contact with the thoracic wall. A diagnosis of an encapsulated empyema was made. Another examination, six months later, showed an increase in size and an erosion of the fourth rib, extending about 7 centimeters. The diagnosis was undecided, it being between an echinococcic cyst and a neurofibroma. Clinical means must be employed to make the diagnosis, that is, the exist-

ence of neurofibromatosis of the skin, the negative thoracocentesis, the negative complement fixation test for echinococcus, the absence of eosinophilia, and the marked localized pains. From a roentgenologic standpoint alone, encapsulated empyemas, interlobar empyemas, and echinococcus must be considered. An operation and histologic examination showed that this tumor was a neurofibroma.

H. W. HEFKE, M.D.

Tumors of the Carotid Body: Report of Twelve Cases, Including One of Bilateral Tumor. Fred W. Rankin and William L. A. Wellbrock. Ann. Surg., April, 1931, XCIII, 801.

Abstracts of 12 cases, including one of bilateral tumor of the carotid body, are reported by the authors. In all, they have found 196 cases, after a rather thorough review of the literature.

Anatomically, the carotid body is ovoid, approximately 5 mm. in length, 3 mm. in width, and 1.5 mm. in thickness, and is located on the median and deep aspects of the upper end of the common carotid artery, at its bifurcation into the internal and external trunks. It is firm, of grayish or brownish color, with a fibrous capsule, and contains a hilum at which its arterial blood supply enters. Its two essential elements are blood vessels and cells.

When tumors affect this body they become lobulated or globular and are always encapsulated. A tumor of the body is often designated as "adenoma," "endothelioma," "perithelioma," "paraganglioma," "neuroblastoma," "sarcoma," or simply "carotid body tumor." The last term seems a sensible one until a better term is agreed upon by pathologists. About 80 per cent of the tumors of these bodies are benign, while 20 per cent are malignant. Metastasis to the liver was found in one case, although, as a rule, such is rare. The general structure consists of epithelial cells packed in an endothelial-lined alveolus.

A symptomless lump in the neck, which pulsates without an expansile quality and is usually movable, is the general clinical picture. Operative removal is usually attempted and the prognosis varies, depending on whether one, two, or three carotid vessels demand ligation.

The patient with the bilateral tumor had one benign and one malignant mass. In the 12 cases (Mayo Clinic), 6 tumors were malignant and 7 benign. Roentgenotherapy was not reported in this paper.

F. B. MANDEVILLE, M.D.

The Roentgenologic Diagnosis of Intrathoracic Tumors. Viktor Mandler. Röntgenpraxis, Feb. 15, 1931, III, 151.

The author reviews and describes the roentgenologic symptoms of intrathoracic growths in this excellent and extensive treatise. A large number of reproductions of films help to demonstrate the pathologic changes. Not only primary tumors of the lungs are included, but also metastatic tumors and mediastinal and pleural growths. The author describes the roentgenologic differential diagnosis in detail. The article deserves study in the original.

H. W. HEFKE, M.D.

The Incidence of Brain Tumors in Epilepsy, as Revealed by Routine Encephalography. Nicholas Gotten. Jour. Am. Med. Assn., April 4, 1931, XCVI, 1118-1121.

The use of lumbar insufflation of air to replace cerebrospinal fluid has made possible roentgenographic studies of the brain that clearly show the gross lesions and deformities otherwise undemonstrable. Reports of various observers indicate the value of this procedure in the accurate diagnosis and localization of obscure cerebral lesions.

The encephalogram has demonstrated its greatest value in determining the origin of the convulsions which occur after the third decade of life. Convulsive disorders are often the initial symptoms of brain tumor and often lead to the erroneous diagnosis of epilepsy when the lesion lies close to the motor areas. The normal pathways and encephalographic pattern are shown.

The interpretations of the obstructions to the cerebrospinal fluid pathways, their charac-

teristic changes, and the resultant brain atrophy are reviewed. Filling defects produced by tumors are in sharp contrast to the shrinkage and brain atrophies noted in the degenerative lesions. Plastic arachnoiditis must be differentiated from cerebral neoplasm, but here in the presence of an invasive or progressive growth the ventricular outlines and displacements are diagnostic.

The ventricles may be encroached on, displaced or depressed by the tumor or invasive lesion, whereas plastic arachnoiditis and cortical scar formation produce a traction and distortion of the roof of the ventricle, drawing it toward the area of the lesion.

Three cases of brain tumor, disclosed in routine encephalographic studies on epileptic patients in whom the only prominent symptoms were convulsions, are reported.

The final diagnosis was made only by the completion of the studies by injection of air. One of these cases showed an erosion of bone in the frontal region. An encephalogram clearly demonstrated the presence of a large cerebral neoplasm. The other two showed deformities of the ventricular outline and the patterns of the fluid pathways, which indicated a filling defect and invasive lesion. The size and location of the tumors were easily visualized.

CHARLES G. SUTHERLAND, M.D.

Studies of Diseases of the Lymphoid and Myeloid Tissues. II.—Plasmatocytomata and Their Relation to Multiple Myelomata. Henry Jackson, Jr., Frederic Parker, Jr., and James M. Bethea. Am. Jour. Med. Sci., February, 1931, CLXXXI, 169.

The authors have rather thoroughly reviewed the literature on multiple myelomas, and have added five case reports to substantiate their belief that multiple myelomas of the plasma-cell type at least should be classed among the malignant lymphomas. That the disease in its classical form is largely limited to the bones does not militate against such a view, when one considers the marked variation of the disease pictured and the gradual manner in which the cases blend into each other.

In the first case cited, a plasmocytoma of the tonsil was removed eight years before generalized bone involvement could be detected, although for fully seven years the process was spreading through the lymphoid system, as successive lymph nodes were involved. The histology of the lymph nodes and bone lesions at autopsy were identical.

In the second case, it is difficult to say whether the lesions appeared first in the bones or in the lymph nodes, although a lesion in a lymph node first brought the patient to the hospital.

The third case was, again, a plasmocytoma, with no bone lesions, but sufficient time had not elapsed since the discovery of the primary lesion.

ROE J. MAIER, M.D.

TUMORS (THERAPY)

Roentgen Irradiation of Malignant Tumors of the Pharynx. F. R. Nager. Schweiz. med. Wchnschr., Feb. 28, 1931, LXI, 212, 213.

The author has followed the technic of Regaud and Coutard in the irradiation of fifty patients who had malignant tumors of the pharynx. A filtration of from 1 to 3 cm. of copper was used, and a focal skin distance of from 60 to 100 centimeters. Treatment was given twice daily through several ports, and the total dose varied from 50 to 150 S.E.D. Rather severe local reactions were sometimes encountered. The results appeared to be favorable, but a long enough period has not elapsed from the time the treatment was first instituted to permit the author to draw final conclusions.

Several case reports are given.

H. C. OCHSNER, M.D.

Radiotherapy in the Treatment of Uterine Fibromyomas. Jackson W. Landham. Jour. Florida Med. Assn., October, 1930, XVII, 171.

The great majority of uterine fibroids in this country are removed surgically, while

many European gynecologists refer such patients for radiation. During the last seven years at St. Luke's Hospital (New York), according to Wood, 1,443 fibromyomas were removed surgically and only twenty such patients were referred for radiotherapy. Under the proper classification of fibromyomas, the treatment should be either observation, operation, or radiation. Small symptomless fibroids discovered in routine pelvic examinations may be kept under observation. Fibromyomas complicated by active pelvic inflammatory disease should be treated surgically, as should those associated with pain, those that are large, hard, or degenerating, those complicated by malignancy of the body of the uterus, and those producing pressure symptoms interfering with the function of the bladder or rectum. With these exceptions, practically all fibromyomas will respond satisfactorily to radiation. The X-ray is advocated in preference to radium because the patient is ambulant, there is usually no post-irradiation sickness, and it is more economical.

The author's technic is to give an erythema dose over the posterior pelvis at one sitting, at 180 K.V., 50 cm. distance, with ¼ mm. copper and 2 mm. aluminum. The anterior aspect is divided into two areas and the treatment is repeated in four weeks. Usually two such series are required to produce a menopause, but in patients under 40 years of age additional treatments may be required.

W. W. WATKINS, M.D.

The Suprarenal and Tumor Growth. William H. Woglom. Am. Jour. Cancer, April, 1931, XV, 704-706.

The author injected suprarenal extract from rabbits who had been inoculated with carcinoma 63 and sarcoma 180 into mice bearing these strains, and also suprarenal extract from normal rabbits. No demonstrable inhibitory effect was noted in either instance. He concludes, therefore, that the treatment of human patients with preparations of the suprarenal gland becomes an "idle and indefensible experiment."

JOHN R. CARTY, M.D.

The Diagnosis and Treatment of Lymphosarcoma of the Upper Air and Alimentary Passages. E. Luscher and H. Scartazzini. Schweiz. med. Wchnschr., Feb. 28, 1931, LXI, 193-201.

After a review of 13 cases of lymphosarcoma in the regions of the pharynx, the author concludes that the treatment of these tumors belongs in the domain of radiotherapy. He feels that they should be considered apart from other sarcomatous lesions. Sixty per cent of 11 cases followed for a period of from six months to five years were free of symptoms or recurrence. These results show that the viewpoint that radiotherapy produces only temporary results is not justified. Most of the cases described were treated with radium at a distance, although in some cases radium was inserted directly into the tumors. In these, radium and X-ray therapy were combined.

H. C. OCHSNER, M.D.

Choriomas. Henry Schmitz. Am. Jour. Obst. and Gynec., February, 1931, XXI, 256.

Tumors of the chorion may be benign or malignant. The benign growths comprise the simple hydatid mole or chorioma simplex and the invasive hydatid mole or chorioma accreta. The malignant group includes the typical malignant chorionepithelioma and the atypical malignant chorionepithelioma. The diagnosis is made from the symptoms, history, tissue examination, and hysterosalpingography, although this must be employed with caution, due to the possibility of forcing chorion through the tubes. The Aschheim-Zondek test is of some differential value.

The author reports 8 cases of chorionepithelioma. Two cases in which radium was introduced into the uterus and roentgenotherapy was employed externally have both remained well, 13 and 2½ years, respectively. Three cases in which roentgenotherapy was employed as a post-operative measure have all remained well 2 years, 1½ years, and 1 year, respectively. One patient upon whom roentgentherapy was used to treat metastases to the

brain and elsewhere died in three months. Two patients were operated upon, with no post-operative treatment; one of these died 19 days after the operation, and one has remained alive and well for 1½ years.

The author concludes that irradiation alone or as a post-operative measure is definitely indicated in these cases. Similar observations on the benefit derived from irradiation have been reported by Naujoks, Gordon, Szathmary, Loebe, Klein, and others.

JACOB H. VASTINE, M.D.

Difficulties in the Radiation Therapy of Internal Malignant Tumors. E. Hayer. Strahlentherapie, 1931, XL, 50.

The author emphasizes the difficulties usually encountered in the radiation therapy of internal malignancies, and relates the history of a case illustrating this fact. A man, 50 years of age, came to the clinic in September, 1929, complaining of pain in the region of the stomach and saying that he had lost thirty pounds in weight during the last year. X-ray examination of the gastro-intestinal tract was negative. A tumor was, however, suspected in the gall-bladder region. Following the application of roentgen rays of short wave length in fairly high doses, there was a period of considerable relief, lasting about six months. The patient returned then to the clinic in very poor general condition; roentgenograms of the chest showed metastatic carcinoma of the lungs. An autopsy revealed a necrotic carcinoma at the papilla of Vater, with extensive metastases to the liver and lung.

ERNST A. POHLE, M.D., Ph.D.

Results of Irradiation Therapy of Malignant Tumors in the Year 1930. Hans R. Schinz. Röntgenpraxis, March 1, 1931, III, 202.

Following the example of the Radiumhemmet, the result of irradiation therapy of malignant tumors in the Roentgen Institute of the University of Zurich is published. This not only includes the cases treated during the year but also the follow-up statistics of cases treated in former years. The author suggests that every clinic or institute should follow this plan in order to collect large groups of statistics. Skin and gynecologic carcinomas are not treated in the author's institute, but in the respective clinics. The statistics appear complicated because not only cures are reported but also palliative results. Palliation is unfortunately under-valued by the surgeons, but incurable cases of carcinoma may often be markedly benefited. Pre-operative irradiation is the method of choice, but is not always possible.

Two hundred thirty cases of malignant tumors are reported. Of these, 53 were symptom-free for one or more years; 9 were locally symptom-free, but had metastases; 12 were symptom-free, but had a recurrence and again became symptom-free or were improved; 27 were improved or non-progressive; 35 showed no improvement, and 25 are still under treatment. Of 39 cases of malignant tumors admitted to the Surgical Department, 28 were referred to the Radiological Department for irradiation therapy.

H. W. HEFKE, M.D.

The Question of Roentgen Therapy in Brain Tumors. J. Heinismann and L. Czerny. Strahlentherapie, 1931, XL, 302.

The authors have analyzed the cases of brain tumors observed in their clinic, with the exception of tumors in the region of the sella turcica, and present the following conclusions. In glioma of the brain, which, according to the literature, is highly susceptible to roentgen rays, the results obtained by X-ray therapy are not so good that it is permissible to irradiate without previous operation. X-ray therapy is indicated only in the afibrillar type of glioma, either following operation for prophylactic purposes or as a trial in inoperable cases.

Inoperable malignant brain tumors, primary as well as metastatic, very often respond well, temporarily, to roentgen rays. The treatment prolongs the life and very often the patient may return to work. A certain percentage of the good results seen in cases of so-called brain tumor without operative control is due, in the authors' opinion, to the fact that tumors were not actually present, but a serous meningitis. Improvement in cases in which

the tumor itself does not show any changes following irradiation are not due to an inhibitory effect of roentgen rays on the choroidal plexus, as assumed by Marburg and Sgalitzer. An early reaction following treatment cannot safely be excluded by using the fractional dose method. The best precaution is a decompression. This should be carried out not only to relieve pressure but also as an exploratory operation.

ERNST A. POHLE, M.D., Ph.D.

ULTRA-VIOLET LIGHT

Antigenic Power of Ultra-violet-irradiated Tetanus Toxin. Emerson Megrail and Henry Welch. Proc. Soc. Exper. Biol. and Med., February, 1931, XXVIII, 494.

The authors observed that an ultra-violet irradiation of two minutes with the "C" carbons failed to destroy the tetanus toxin, as one-half of the inoculated animals developed late tetanus. A further irradiation of two minutes, however, completely destroyed the toxin. Subsequently, the guinea pigs were each given five subcutaneous injections of one minimum lethal dose of irradiated toxin, at intervals of six or seven days. Three weeks later they were inoculated with freshly titrated toxin of from 1 to 10 minimum lethal doses, and no signs of tetanus developed.

J. N. ANÉ, M.D.

The Influence of the Wave Length in the Irradiation of Ergosterol. E. Kisch and T. Reiter. Strahlentherapie, 1931, XXXIX, 452.

In 1927, the authors exposed milk to ultra-violet rays. If the radiation extended below 2,800, a disagreeable odor developed in the milk. Considering this experience, they carried out studies with ergosterol in the form of 0.5 per cent solution in olive oil. This was irradiated with a quartz mercury vapor lamp, either with the entire spectrum or when cut off at 2,800 Ångströms. In the first case, the absorption spectrum showed a maximum at 2,450 and 2,700 Ångströms. If the irradiation was continued, these maxima became weaker and new absorption bands appeared at 2,800, 2,950, and 2,700 Ångströms. These relations were quite different if the spectrum was used only as far as 2,800 Ångströms. After a few minutes' exposure, there appeared a definite absorption between 2,550 and 2,750 Ångströms. Continued irradiation increased this and the maximum effect was obtained after about two hours.

The solutions exposed under the two conditions mentioned above were used in animal experiments (rats on rickets diet); the ergosterol irradiated by the filtered spectrum of the quartz mercury vapor lamp could be given in much higher doses without producing toxic reactions. It was tested clinically in 51 tuberculous children, who gained about 8 per cent in weight under its administration during a period of several months.

ERNST A. POHLE, M.D., Ph.D.

Combined Treatment of Rheumatism with Infra-red and Ultra-violet Body Exposure. I. Gunzburg. Strahlentherapie, 1931, XXXIX, 798.

For the combined treatment of rheumatic patients, the author constructed an electric bath permitting the patient to lie down in comfort. The temperature easily reaches 70 degrees centigrade and is usually tolerated for from thirty to thirty-five minutes. During the bath the patient's head is cooled by wet towels. After fifteen minutes of rest, an exposure to the quartz mercury vapor lamp is the next procedure. A warm and cold douche or an alcohol rub finishes the treatment.

ERNST A. POHLE, M.D., Ph.D.

A Few Brief Remarks Concerning Ultra-violet Radiation. A. Rosselet. Strahlentherapie, 1931, XXXIX, 794.

As early as 1907, the author compared the ultra-violet intensity available in the plains and mountains, using a very simple apparatus for the tests. They resulted in practically the same conclusions as obtained by Dorno, with very accurate instruments. It appeared that the ultra-violet intensity of the sun is much higher in the mountains than in the lowlands.

The difference decreases, the closer one gets to the summer season; it is appreciable only during the winter.

ERNST A. POHLE, M.D., Ph.D.

The Effect of X-ray, Infra-red, and Ultra-violet Rays upon the Rutting Hormon. F. Ludwig and J. v. Ries. Zentralbl. f. Gynäk., Jan. 17, 1931, LV, 137.

In an experimental study in mice, the authors discovered the following: (1) The X-ray has no effect upon the rutting hormon; (2) ultra-violet renders it ineffective; (3) infra-red increases its effectiveness to at least twice the normal strength, and (4) the ineffectiveness produced by ultra-violet may be eliminated by irradiation with infra-red.

Biologic Investigations Concerning the Transparency of Gypsum and Mica in the Ultra-violet Region. Tomoshige Takagi. Strahlentherapie, 1931, XL, 189.

Hausmann and Krumpel studied the transparency of gypsum and mica for the radiation emitted by a quartz mercury vapor lamp, with the spectrographic method. The author repeated these experiments on biologic objects, namely, blood agar and human skin. In confirmation of the results obtained by Hausmann and Krumpel, he found that mica does not transmit, biologically, effective ultra-violet radiation, while definite reactions were obtained from the rays passing through gypsum.

ERNST A. POHLE, M.D., Ph.D.

Concerning the Merits of Treatment Rooms for Mass Ultra-violet Irradiation. A. Lippmann and F. Dannmeyer. Strahlentherapie, 1931, XXXIX, 650.

In order to determine the dose per time unit received by a patient walking in a room flooded with ultra-violet light from a series of lamps, the authors fastened twenty pieces of slow photographic paper on various parts of the body. Following exposures for a definite time, the paper was fixed and the degree of blackening compared with an arbitrary scale. The results obtained suggest the best way of arranging the lamps in the treatment room: It was, in this case, the grouping of four lamps in a circle of four meters diameter. Other tests showed that additional exposure to a Sollux lamp (radiant heat) did not improve the results obtained by ultra-violet light alone. The tests were checked with a cadmium cell; although there appeared to be quantitative differences, the principal conclusions were confirmed.

ERNST A. POHLE, M.D., Ph.D.

The Combined Effect of Roentgen and Ultra-violet Light. Karl Steiner. Strahlentherapie, 1931, XXXIX, 500.

The cornea of salamander larvæ was exposed to ultra-violet and roentgen rays in various combinations. In all cases the roentgen reaction was enhanced by additional ultra-violet exposure. This cannot be interpreted, however, as a cumulation, in the sense of a true sensitization, but merely as a non-specific co-addition.

ERNST A. POHLE, M.D., Ph.D.

The Effect of the Ultra-violet, Sun, and Sky Light on the Thyroid of Rats, with Consideration of the Basal Metabolism Rate. Walther Bergfeld. Strahlentherapie, 1931, XXXIX, 245.

The histological changes in the thyroid of rats were studied following exposure of the animals to different parts of the spectrum. One group received radiation cut off at 3,500 Å.; another group received radiation cut off at 3,100 Å., and a third group received radiation as low as 2,600 Å. For control purposes some rats were kept in the dark. Since previous experiments carried out in different places revealed discrepancies in the results, animals were treated alike in Bern, Freiburg, and Berlin. The periods of observation in each group run from 21 to 42 to 63 days. In some cases, extracts were made from the skin of the rats exposed to ultra-violet light of long or short wave length, and then injected into the animals kept in the dark. All rats, regardless of the place where they were treated, if they were kept in the dark or had been exposed to radiation cut off at 3,100 Å., showed identical

histological changes in the thyroid. They consisted of an increase in the follicles, lack in colloid, and an extremely high follicle epithelium. These findings could not be correlated with the basal metabolic rate. In animals treated by ultra-violet rays down to 2,800 Å., no similar changes could be observed. Those rats which had been kept in the dark and then injected with skin extract obtained from animals exposed to short ultra-violet rays showed a definite improvement in the histological picture, as compared with the uninjected rats or rats which had been injected with extract obtained from animals exposed to ultra-violet rays of long wave length.

The author believes that he has proven, therefore, that the described changes in the thyroid of rats can be prevented or decreased by ultra-violet rays between from 3,100 to 2,800 Å. The effect takes place by the so-called humoral route.

ERNST A. POHLE, M.D., Ph.D.

The Electrophysiologic Changes in the Skin Following Exposure to Ultra-violet Light. Philipp Keller. Strahlentherapie, 1931, XXXIX, 320.

Immediately following exposure to ultra-violet light, there are no definite changes in the electric reaction of the skin. As soon as the erythema appears, that is, from two to five hours following the exposure, there is a slight increase of the polarization. Sometimes one also finds a slight change of the basic potential towards the positive. At the height of the erythema, the polarization is more or less decreased and the basic potential considerably more positive. This must be interpreted as an injury to the epidermic membrane. The tonus potential is also decreased and the intensity of the Tarchanoff reflexes diminishes. In other words, the parasympathetic tonus and the parasympathetic irritability are definitely decreased in the erythema area. With the disappearance of the erythema, the polarization increases while the potential still remains positive. The tonus potential decreases further and occasionally the Tarchanoff reflexes can not be released. A number of curves illustrate the findings.

ERNST A. POHLE, M.D., Ph.D.

International Congress for Pediatrics. Richard Hamburger. Monatschr. f. Kinderheilk., Feb. 23, 1931, XLIX, 212-219.

The biological effect of direct and indirect ultra-violet irradiation was discussed extensively by authorities from various parts of the world. The discussion was opened by A. F. Hess, of New York, who set forth the uses, dosage, etc., of irradiated ergosterol. H. J. Gerstenberger, of Cleveland, reported his findings in the examination of wet nurses who were given the substance for the purpose of combating rickets in their nurslings. Other speakers were Gorter, of Leyden; György, of Heidelberg; Lesne and Celment, of Paris; Medowikoff, of Leningrad; Spyropoulos, of Athens, and others. They all discussed the effect of irradiated ergosterol and similar substances; also direct irradiation with ultra-violet light upon rickets, and reported good results.

The Ultra-violet Absorption of Proteins. Heinrich Guthmann, Kurt Schwerin, and Fritz Stähler. Strahlentherapie, 1931, XXXIX, 401.

Clinical and biological observations suggest that proteins are important factors in the mechanism of the light erythema. A number of amino acids were analyzed by the authors as to their ultra-violet absorption. From the results obtained in these acids in biologic concentration, the chemical compositions of albumin, globulin, and fibrin were calculated. It appeared that there were two maxima of absorption in the synthetic mixture located at 3,000 and 2,500 Ångströms. A comparison of the theoretical curves with the absorption curves of serum and chicken albumin showed that tyrosin, phenylalanin, and gultamin acid are the strongest absorbers. Further studies on compounds belonging to the propion acid group demonstrated the fact that molecular weight does not influence the absorption phenomena but that there is a definite de-

pendence on the sterochemical structure. Organic compounds belonging to the following groups effected the absorption in the order in which they are named: Aldehyde group (most effective), amino group, COOH group, and alcohol group.

Forty-seven graphs and fifteen tabulations illustrate the results.

ERNST A. POHLE, M.D., Ph.D.

Medication and Ultra-violet Rays. Gr. Roskin. Ztschr. f. Immunitätsforsch. u. exper. Ther., January, 1931, LXIX, 473.

This is an experimental study in mice, in which the author sought to determine the combined effect of ultra-violet rays and medication. The mice were infected with tincture equiperdum. Examination revealed that the serum of mice treated with ultra-violet rays contained a particular factor *A*, which intensified the therapeutic effect of neosalvarsan.

This factor *A* disintegrates if the serum is kept at a temperature of 56° C. for half an hour; it also disintegrates if the serum is exposed to ultra-violet radiation. Absorption of factor *A* from the serum may be accomplished with kaolin. Observation showed participation of the active mesenchyma of the skin and the entire reticulo-endothelial system in the production of factor *A*. The serum of irradiated, splenectomized mice contains little factor *A* or none at all.

The Formation of a Compound from Histidin under Ultra-violet Radiation, with Effects Similar to Those of Histamin, and the Significance of this Process for the Light Erythema. F. Ellinger. Strahlentherapie, 1930, XXXVIII, 521.

Histidin in solution exposed to ultra-violet rays is partly transformed into histamin, which produces contractions in the surviving intestines of guinea pigs. The wave length of the light does not seem to be of influence as long as the radiation belongs to the ultra-violet region. If the histidin is dissolved in serum and then irradiated, the exposed solution also produces a contraction of the intestines. The skin of small pigs was exposed to ultra-violet rays and pieces excised in the erythema area. Extracts of the excised skin also produced contraction of the intestines in several instances. As to the mechanism of the skin erythema, the author believes that, following exposure, a histamin-like compound is formed from histidin in the upper layers of the epidermis. This causes the first reddening and the histologic picture of leukocyte grouping in the blood vessels. Depending upon the type of radiation and its intensity, injurious effects on the prickle-cells may be added. The substance released by these cells increases the erythema.

ERNST A. POHLE, M.D., Ph.D.

Biology and Practical Use of the Threshold Erythema for Ultra-violet Rays. V. Wucherpfennig. Strahlentherapie, 1931, XL, 201.

This article is a detailed report of the author's extensive studies concerning the skin erythema, following exposure to ultra-violet rays. He has used the so-called threshold value of the erythema, and it was surprising how small a difference in the dose applied could be recognized with this procedure. The simple apparatus is described and sketched. The relations between threshold erythema and age, complexion, and sex are related; the effect of pressure during exposure, as well as that of the wave length, has also been considered. A very characteristic and almost constant ratio between the reactions was seen in persons who had been irradiated before, either with the mercury vapor lamp or with the sun. A pathologic hypersensitivity to light should be diagnosed only if irradiation of hitherto unexposed skin areas is followed by the typical symptoms of a light dermatosis.

ERNST A. POHLE, M.D., Ph.D.

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